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COLUMBIA-NORTH PACIFIC REGION COMPREHENSIVE FRAMEWORK STUDY OF --ETC(U)
MAY 71 J CALVIN, F H CLOSNER, R J COFFMAN

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Columbia-North Pacific Region

Comprehensive Framework Study
of Water and Related Lands

APPENDIX VIII

VOLUME

LAND MEASURES & WATERSHED PROTECTION

SUBMITTED BY

PACIFIC NORTHWEST RIVER BASINS COMMISSION
1 COLUMBIA RIVER, VANCOUVER, WASHINGTON

MAY 1971

This appendix is one of a series making up the complete Columbia-North Pacific Region Framework Study on water and related lands. The results of the study are contained in the several documents as shown below:

Main Report

Brochure Report

Appendices

- I. History of Study
- II. The Region
- III. Legal & Administrative Background
- IV. Land & Mineral Resources
- V. Water Resources
- VI. Economic Base & Projections
- VII. Flood Control
- VIII. Land Measures & Watershed Protection
- IX. Irrigation
- X. Navigation
- XI. Municipal & Industrial Water Supply
- XII. Water Quality & Pollution Control
- XIII. Recreation
- XIV. Fish & Wildlife
- XV. Electric Power
- XVI. Comprehensive Framework Plans

Pacific Northwest River Basins Commission
1 Columbia River
Vancouver, Washington

USDA-SCS-PORTLAND, OREG. 1971

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Land Measures & Watershed Protection

APPENDIX VIII

6 Columbia-North Pacific Region
Comprehensive Framework Study

Volume 1
[Subregions 1-5]

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APPENDIX VIII
LAND MEASURES AND WATERSHED PROTECTION

Prepared under the direction of the
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This appendix to the Columbia-North Pacific Region Framework Report was prepared at field level under the auspices of the Pacific Northwest River Basins Commission. It is subject to review by the interested Federal agencies at the departmental level, by the Governors of the affected States, and by the Water Resources Council prior to its transmittal to the President of the United States for his review and ultimate transmittal to the Congress for its consideration.

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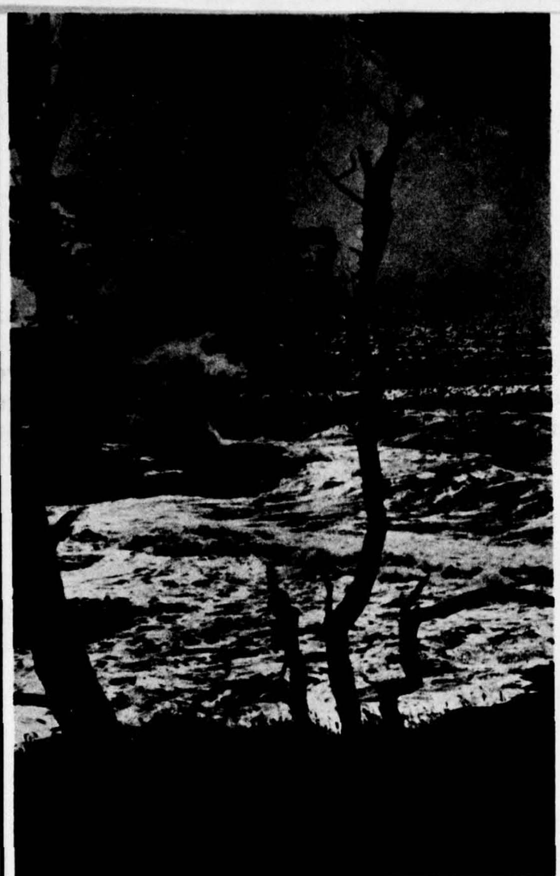

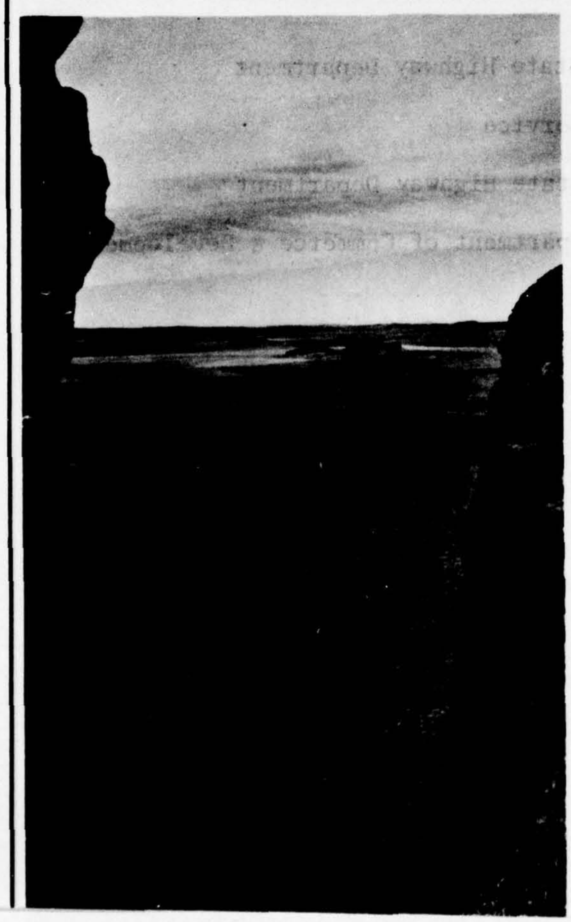

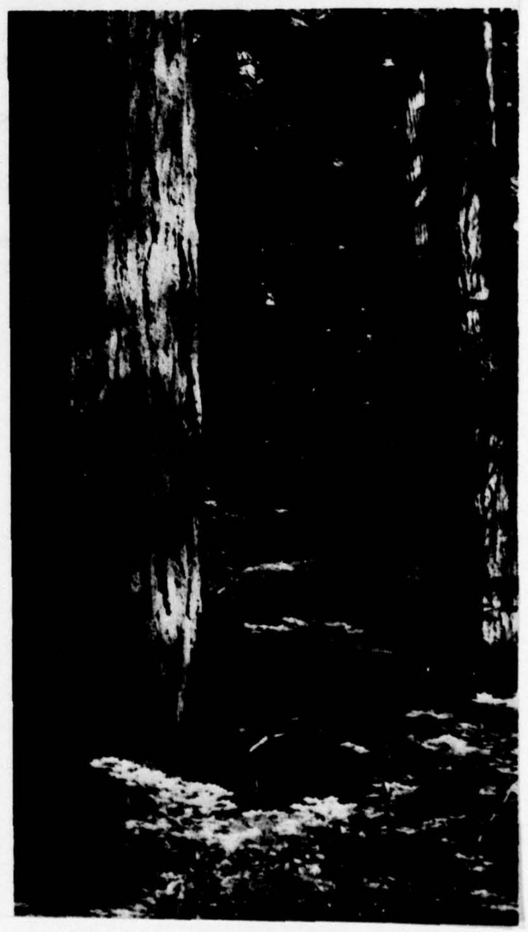

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INTRODUCTION

PURPOSE AND SCOPE

The Land Measures and Watershed Protection Appendix shows current and projected watershed conditions, as affected by use of land and water resources, and presents requirements for improving and protecting the watershed through a combination of management practices, land treatment, and structural measures. The discussions are oriented around the four major land use and cover areas, cropland, forest land, rangeland, and other land, for each subregion.

Measures and practices discussed in the appendix are primarily associated with water quality and use, conservation, irrigation, soil erosion, and drainage. Structures are primarily designed for flood protection, water quality control, and water use development. Land treatment programs include: (1) maintenance of land under its present use; (2) rehabilitation of land damaged through misuse; and (3) development or adjustment of land uses for changing future needs. Primary watershed objectives of these programs are: (1) improved efficiency of irrigation water application; (2) maintenance and improvement of soil productivity and cover; (3) reduction of soil erosion, gullying, and sedimentation; (4) control of salts, plant nutrients (fertilizers), and other chemicals; (5) control of runoff; (6) removal of excess surface and subsurface water; (7) water yield improvement; and (8) water pollution control and abatement.

Current watershed practices and their relationship to land and water resources are pointed out in the Present Status section. The Future Needs section shows projected demands for use of lands and resources and outlines the areas needing watershed improvement and protection by the years 1980, 2000, and 2020. A combination of land treatment and management practices which are required in each of the three future time periods to meet watershed needs and objectives is presented in the Means to Satisfy Needs section.

RELATIONSHIP TO OTHER APPENDICES

Basic information from the Land and Mineral Resources, Water Resources, and Economic Base and Projections appendices, has been utilized in the development and presentation of materials in this appendix. Watershed management and protection is significantly related to flood problems, irrigation, water quality and quantity, recreation, fish and wildlife, navigation, and water power. Watershed management has a direct bearing on the condition of water resources by: (1) directly affecting the volume, timing, and reliability of natural streamflow; (2) affecting water quality; (3) controlling the siltation that reduces storage capacity in

reservoirs; and (4) recharging ground water. Small upstream retarding structures also provide storage for irrigation, recreation, fish, and other uses, assuring a more reliable and regulated water flow. Thus, this appendix is related to all of the other functional appendices.

BACKGROUND

During the early settlement and economic development of the Pacific Northwest, little consideration was given to water conservation or protection of the apparently inexhaustible water supply. The exploitation of timber, minerals, and grassland along with poor farming practices have all contributed to present conditions of the watershed.

Cropland

The first settlers arrived in the Pacific Northwest between 1820 and 1840, and in 1846 the United States and England settled their disputes concerning the Oregon Territory. The Federal policy during this period was concerned with offering lands for permanent occupation. Congress agreed that benefits to be derived from permanent settlement far exceeded the financial return from sale or lease of lands.

Congress opened the northwest to settlement with the passage of the Donation Land Act in 1850. This act allowed married settlers to acquire title to 640 acres, providing they occupied and cultivated the land for 4 years; settlers claimed millions of acres under this and subsequent acts.

By 1900, most of the productive agricultural land had passed into private ownership; and, out of the remaining 28 million acres of unreserved and unappropriated public land, little was suitable for farming.

Little attention was given the problem of suitable land use in settlement of the Public Domain, resulting in serious misuse of land. Farmers sometimes cleared and farmed land that could not provide them an adequate living. Lands were dry-farmed where insufficient rainfall or severe erosion precluded successful crop production over extended periods of time. This brought about a serious erosion problem, which is evident in many parts of the region. Its extent is dependent on the land use, type of soil, vegetative cover, slope, and amount and intensity of rainfall. Excessive winter rains and rapid snowmelt on inadequately protected soils are also major contributors to the erosion problem.

Because of the past mismanagement of the soil, its natural fertility has continually declined. Usually, more organic matter and chemical elements have been removed from the soils by harvesting and removing plants or by leaching than have been returned to the soils. In addition, irrigation in arid and semiarid areas and natural infiltration of precipitation into the soil in humid areas have leached plant nutrient elements from the soil.

Water supply problems consist of three kinds; excess, shortage, and quality. The major water problems are caused by the fact that seasonal distribution of precipitation and runoff are generally the reverse of those needed by agriculture. Streamflows are generally highest in the late winter and early spring and lowest in late summer and early fall.

Drainage has always been a problem in many sections. This problem generally occurs in areas of heavy soils and in areas with restricted or impermeable subsurface layers. Some of the damages that have resulted from inadequate drainage are: (1) decreased production; (2) limited growing season; (3) restricted land use; (4) limited selection of adaptable crops; (5) swamp areas; (6) mosquitoes; (7) water pollution; and (8) increased cost of operating farm equipment around wet spots. Many of these problems have restricted agriculture by preventing the operator from making needed changes essential for the proper use of land within its capabilities.

Past abuse of the land is the primary factor contributing to soil deterioration, erosion, and reduced crop production. When cropland is used within its capabilities, soil fertility is sustained or improved, requiring less extensive treatment measures.

Forest Land

The first Pacific Northwest settlers found much of the area covered by forest. They may have recognized this as a tremendous resource, but it also created difficulties in their subsistence. Clearings for crops and livestock were necessary in order to live. Lumber was needed for the construction of buildings, fences, and mines. Wood was needed to supply homes and industries with fuel. Logging, land clearing, mining, and fire damages greatly altered the original forest cover, significantly affecting water resources.

Soil damage was slight as long as cutting was confined to river and tidewater areas. As logging progressed inland, terrain was rugged and the ground disturbance increased. The timber supply was considered inexhaustible; therefore, protection and conservation practices were nonexistent.

The conservation of forest resources was conceived at the turn of the century. The first forest reserves, established from remaining Public Domain, aimed to improve and protect the forest, secure favorable water flows, and furnish a continuous supply of timber. The Weeks Act of 1911 authorized the Federal Government to purchase cutover timberlands for national forests. The act was passed in order to acquire forest lands needed to protect soil, check fires, reduce sediment in navigation channels and reservoirs, provide more even flow for electric power, conserve scenery for recreation, and manage economic resources with a broad social view.

Changes in the general outlook of the Nation toward conservation occurred during the 1930's; consequently, it became an important element in the management of the Federal forests. Fortunately, most of the forest lands that had been logged were located at lower elevations where soils were deep and slopes fairly gentle, making road construction and logging easier and causing less ground disturbance. Had this logging occurred in higher forested watersheds, soil would have suffered to an even greater extent.

Major logging on public land began after World War II, when new and heavier logging and road construction equipment was introduced. Roads penetrated deeper into uplands. Larger log loads, faster trucks, and more recreation traffic necessitated improved road alignment and larger road cuts and fills. As logging and road construction became more difficult, more ground was disturbed, which accelerated stream sedimentation and gully erosion. Timber harvesting still included only limited objectives and protective measures to prevent or reduce excessive erosion and sedimentation. Realizing the inadequacy of existing protective measures, northwestern states passed conservation acts requiring landowners to leave their lands in a productive condition.

In addition to harvesting of wood products, grazing of the understory vegetation was established early in the settlement of the west, particularly in the more open forest types east of the Cascade Mountains. A seasonal progression of grazing from the low elevation grasslands into the forest zones formed the basis for an extensive livestock industry. Uncontrolled livestock use on the forest lands led to deterioration of forage plants and destruction of the forage production capability. Ground disturbance and compaction resulted in undesirable watershed conditions despite the protective forest canopy above.

Recognition of the destructive character of unregulated grazing practices in the early 1900's led to a gradual improvement in grazing practices. Since the 1900's, control of livestock has been intensified by implementation of ranch management plans prepared with Federal and State assistance. Public forest land

grazing has improved significantly since the creation of the national forests. In recent years, the application of range science techniques to forest rangeland has resulted in the establishment of grazing systems which provide for effective livestock distribution and control for the benefit of both watershed protection and livestock production.

Big game species as grazing animals often precipitate serious watershed problems. Large concentrations of big game animals can be as effective in watershed destruction as domestic livestock. While livestock can be controlled through grazing systems, big game species are less efficiently controlled through hunting management. Reductions in livestock numbers have often been accompanied by increases in big game populations. The adverse impact on watershed condition resulting from increased game animal numbers has only recently become more commonly recognized. Techniques of big game management are being improved to be more fully compatible with watershed values.

Nearly half of the Columbia-North Pacific Region is classified as forest land. Much of this land is located on steeper slopes where use is limited by the effects of water-caused soil erosion. Improvements in forest land protection are substantial; however, additional progress is still possible.

Rangeland

Many acres of rangeland have been overgrazed and otherwise abused during the past 100 years with a deterioration of both plant cover and soil condition. Water infiltration rates have decreased with a corresponding increase in runoff, causing severe erosion, changes in streamflow, downstream flood damage, and siltation of reservoirs and irrigation structures. In addition to overgrazing by livestock and big game, which use nearly 70 percent of the range, further damage has been caused by fire, rodents and insects, and severe weather fluctuations.

In the 1860's and 1870's, abundant livestock forage was found on natural grasslands of the Snake River Plains and Columbia Plateau. Cattle and sheep ranching increased rapidly during this period. Under the land settlement laws, individual settlers could not acquire title to sufficient acreage for a year-round livestock enterprise; therefore, expanding livestock operations quickly spread onto Federal rangeland. Although the law did not prohibit such use, neither did it provide for range preference rights. Year-round grazing on the open range began, destroying much of the native grass and browse plant cover needed to stabilize soil and conserve moisture. Uncontrolled competition for rangeland use coupled with lack of legal land rights provided no incentive for long-term range and watershed protection.

Rangeland conditions at the turn of the century are revealed in the following quotation:

> "The public ranges of the region are in many places badly depleted and furnish at the present time not over one-third of the feed which they once did. This is directly traceable to overstocking, and it does not appear clear how matters would improve in the near future as long as there is no inducement for anyone to do aught but get all he can out of the little that the country does produce. The areas of absolutely depleted range on the mountains, and the most productive of any in the region, and really the only grazing grounds, are rapidly increasing . . ."

> "Clearing the ground of grass is not the only evil effect, as is well known. The destruction of shrubbery, all too scanty in this region, has a potent influence on the lowland meadows and the mountains themselves, both in relation to the conservation of the moisture and the protection of the surface soil from the erosive action of water. The destruction of vegetation means vastly more than simply depriving the cattle of food, in the particular locality where close pasturing is practical."(7) 1/

In 1906 the USDA, Forest Service, initiated a permit system to allocate grazing rights and control livestock use on rangelands under its jurisdiction. Not until 1934 was legislation enacted to curb the continued abuse on most Federal rangelands in the Northwest. A major objective of the Taylor Grazing Act was "to preserve the land and its resources from destruction or unnecessary injury and to provide for the orderly use, improvement and development of the range." In the same year, the President also signed an executive order withdrawing all public land from settlement "to stop injury of the public grazing lands by preventing overgrazing and soil deterioration; to provide for their orderly use, improvement, and development; to stabilize the livestock industry dependent upon the public range; and for other purposes." No longer could the public lands be used for livestock or other use without specific authorization.

In the past 30 years grazing districts have been established on the major Federal rangeland areas, and considerable progress has been made in determining proper grazing capacity and adjusting livestock use to this capacity. Progress has also been made in rehabilitating certain range areas through reseeding, brush control, and other land treatment measures combined with improved management practices. Many range areas have not received proper attention to assure watershed protection as lands and resources are more intensively used to meet constantly changing demands.

1/ Number in parentheses refers to Bibliography on page 727.

Other Land

Other land areas, covering the extremes from barren snowfields and deserts to densely occupied urban areas, have had a history of growth, both as the country grew in size and as the protective cover was stripped by other intensive uses. These lands have included farmsteads, roads and railroads, cities, industrial belts, barren areas, and small water bodies.

Of all the major land uses, only the other land has been increasing at a rapid rate, continuing a trend that has been discernible throughout the settlement of the region. Today other land totals more than 8 million acres and includes such diverse types as barren and urban lands.

Urban land is the segment that is increasing most rapidly. About 100 years ago, there was practically no urban land in the region, but since 1934, the amount has more than doubled. Currently, the region's population has been increasing at 3 percent annually, while the urban population has been increasing at a higher rate. Much of the growth has been in the larger cities where there is a concentration of employment opportunities and potential labor and consumer markets. This increase in urban population has increased the need for lands that are suitable for industrial and residential developments. This has created two serious problems. One, the land now occupied has generally come from high quality agricultural land that is already in short supply. Two, during the period of construction, all trace of protective cover is removed. Sediment from land clearing and contaminants from construction work wash into storm sewer systems or tributary streams and ditches, eventually polluting the area's water sources. This is a problem until the vegetative cover is restored by grass seeding, landscaping, or paving. Paving, although very necessary, is the least desirable solution to construction erosion control. Although it reduces sediment production, it increases runoff considerably. This sometimes transfers the problem to a point downstream. As the region becomes more developed, this problem will increase.

High intensity urban development exerts considerable influence on the land immediately adjacent to it. Inflated land values, high taxes, and other speculation factors tend to create a zone of little used land that often consists of high quality agricultural lands.

Construction of roads and highways has been proceeding at an increasingly rapid rate, especially over the past 20 years. Here too, vegetative cover is significantly disturbed during the construction period. Bare slopes are sometimes left to erode for long periods of time before the construction areas are revegetated. This type of expansion is usually in conflict with other types of land use. Sometimes highly productive cropland is taken up in

wide turnpike type rights-of-way. For instance, rights-of-way 300 feet wide require approximately 36 acres per mile.

Sand dune areas have also increased in size principally because the protective cover has been removed allowing erosion to remove the protective soil. The other barren areas; rock, snow, and ice fields, have remained relatively static. Farm ponds and other small water bodies have also increased greatly in number and total surface area.

REGIONAL SUMMARY

R E G I O N A L   S U M M A R Y

PRESENT STATUS

The Columbia-North Pacific Region is made up of three hydrologic areas: (1) The Columbia River System within the United States; (2) the streams and rivers in Oregon and Washington that drain into the Pacific Ocean and Puget Sound; and (3) the Oregon Closed Basin. The region has an area of 175.6 million acres, which includes 173.7 million acres of land and 1.9 million acres of large water areas. Thirty-three percent of the region is in the State of Oregon, 29 percent is in Idaho, 25 percent is in Washington, 9 percent is in Montana, 2 percent is in Nevada, 2 percent is in Wyoming, and less than 1 percent is in Utah. Washington is the only state completely included in the region. For study purposes, the region has been divided into 12 subregions along major hydrologic boundaries.

Forest is the predominant cover, covering 49 percent of the region's total land area (table 1, figure 1). Rangeland is next occupying 34 percent. Cropland amounts to 12 percent, and other land comprises 5 percent of the total area.

Table 1 - Cover and Land Use, The Region, 1966

Subregion	Cropland	Forest Land	Rangeland	Other Land	Total Area
	----------------------	----------1000 Acres	----------	----------	----
1	1,552.1	18,242.1	1,698.1	1,327.1	22,819.4
2	3,308.8	5,652.1	4,583.9	536.0	14,080.8
3	686.3	1,508.9	1,534.8	121.4	3,851.4
4	3,781.3	4,296.9	13,555.8	1,047.8	22,681.8
5	1,628.9	4,190.5	16,838.7	739.4	23,397.5
6	3,077.8	13,537.1	5,041.8	714.5	22,371.2
7	3,570.6	8,328.3	6,358.1	565.2	18,822.2
8	201.1	2,665.0	67.9	258.6	3,192.6
9	1,456.1	5,272.0	58.8	815.9	7,602.8
10	584.8	13,828.6	168.6	472.2	15,054.2
11	591.0	6,429.0	105.0	1,321.6	8,446.6
12	365.0	1,893.0	8,733.1	403.7	11,394.8
Total	20,803.8	85,843.5	58,744.6	8,323.4	173,715.3

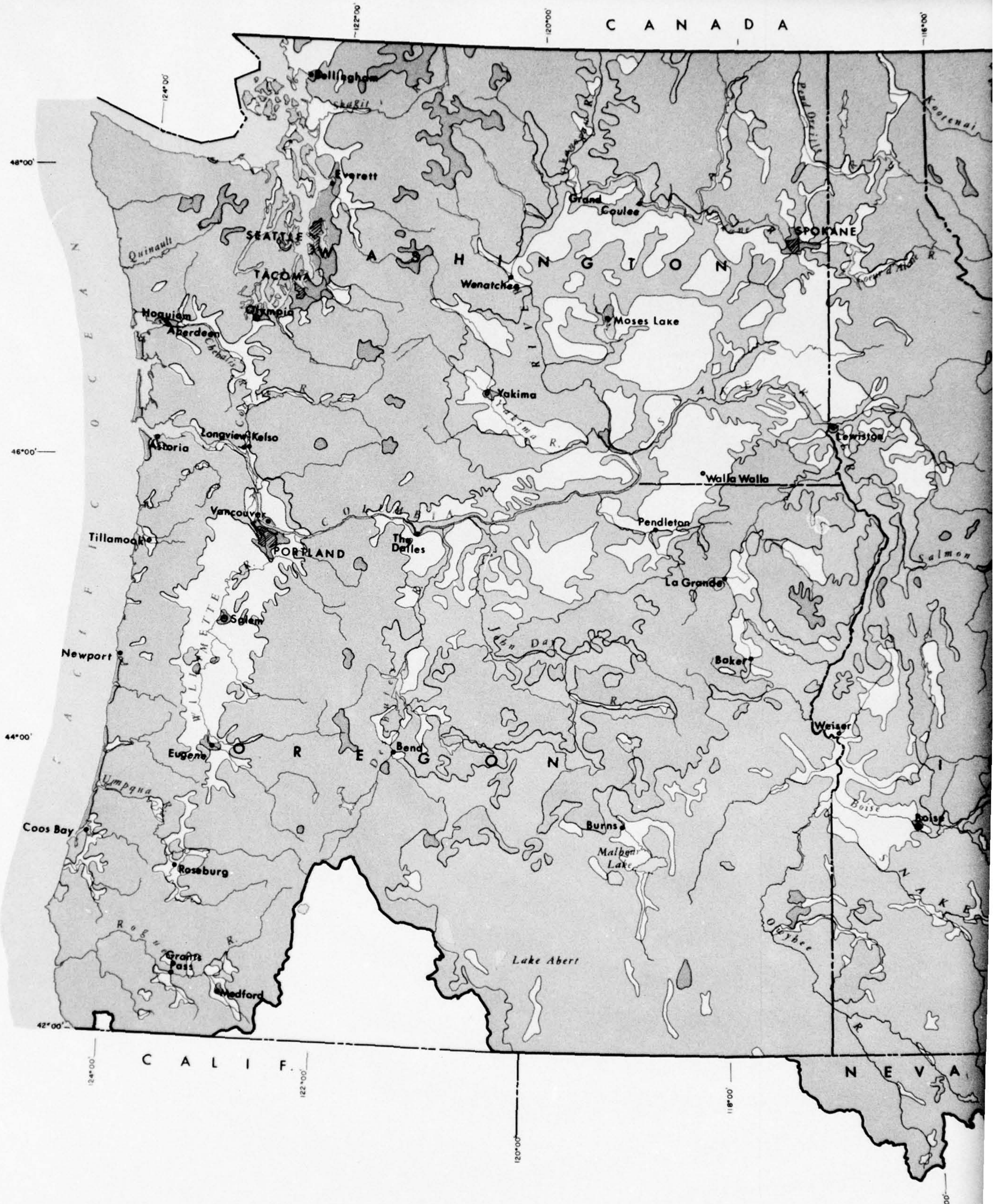
Source: Appendix IV, Land and Mineral Resources

The region can be broken into three general climatological areas: (1) the coastal area; (2) the interior valleys between the Coast and Cascade Ranges; and (3) the area east of the Cascades. Further details on climate can be found in Appendix V, Water Resources.

The coastal area has a humid climate with a strong marine influence. It is characterized by high precipitation, particularly during the winter months, and by moderate year-round temperatures. Annual precipitation ranges from 60 to 90 inches along the immediate coast but increases inland to as much as 200 inches on the summit of the Coast Range. Approximately 60 percent of the precipitation occurs from November 1 through March 31. Normal annual snowfall varies from a trace near the coast to several feet in higher Coast Range elevations. Prevailing winds are generally from the west and northwest, but during stormy periods the wind is from the south to southwest and continuous wind velocities of 15 to 25 miles per hour are common. Winter temperatures are mild, seldom below 20 degrees, even in the Coast Range. Summer temperatures are cool in the coastal fog belt, but are fairly high further inland. Even here temperatures above 100 degrees are rare. The average frost-free season varies from 210 days along the coast to 140 days in the high valleys of the Coast Range. The average frost-free season in most of the agricultural area is 180 to 210 days.

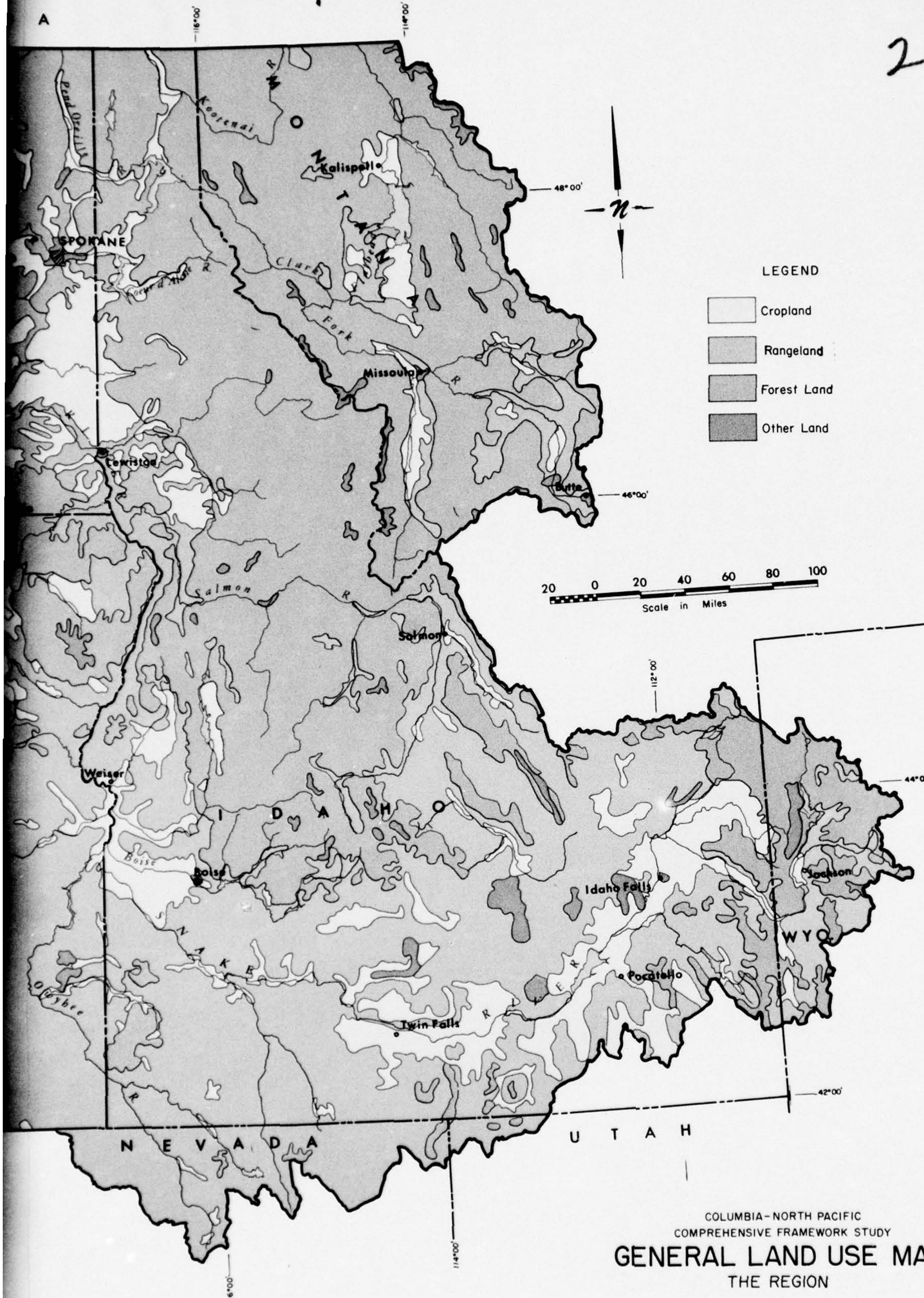
The interior valleys of western Oregon and Washington have a temperate climate characterized by wet winters and dry summers. Topography, nearness to the Pacific Ocean, and exposure to westerly winds are the principal climate controls. Relatively high annual precipitation occurs on the Coast Range to the west with over 200 inches, and the Cascade Range to the east with almost 150 inches. The valley lands are in the rain shadow of the Coast Range and they receive much less precipitation, 35 to 50 inches. At lower elevations, under 500 feet, most of the precipitation occurs as rain. The portion of the annual precipitation falling as snow increases about 10 percent for each 1,000 feet increase in elevation. As in nearly all the region, precipitation is seasonal. On the average 20 percent occurs in the fall, 45 percent in the winter, 25 percent in the spring, and less than 10 percent in the summer. Because the area is largely dominated by maritime air, both the annual and diurnal temperature ranges are relatively small. Cropland areas have relatively long periods between killing frosts, from 210 days in lower valleys to 140 days in higher valleys. However, it decreases to less than 30 days at high elevations in the Cascade Range.

In the area east of the Cascade Range, precipitation varies from less than 10 inches annually to over 100 inches. Snowfall constitutes most of the precipitation in the higher elevations but is irregular at lower elevations. Most of the precipitation occurs in the fall, winter, and spring, with less than 10 percent falling



CANADA
122°00'
120°00'
116°00'
124°00'
48°00'
46°00'
44°00'
42°00'
Bellingham
Skagit
Everett
SEATTLE
TACOMA
Olympia
WASHINGTON
Quinault
Hoquiam
Aberdeen
Chehalis
Grand Coulee
SPOKANE
Wenatchee
Moses Lake
Yakima
Yakima R.
Lewiston
Walla Walla
Longview
Kelso
Astoria
Vancouver
PORTLAND
Tillamook
The Dalles
Pendleton
La Grande
Salem
WILLAMETTE R.
John Day
Baker
Newport
Weiser
Eugene
Bend
OREGON
Umpqua
Coos Bay
Burns
Malheur Lake
Boise
Roseburg
Rogue R.
SNAKE
Grants Pass
Medford
Lake Abert
Owyhee
Salmon
Kootenai
Pend Oreille
CALIF.
NEVA
118°00'
PACIFIC OCEAN

2



COLUMBIA–NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

GENERAL LAND USE MAP

THE REGION

FIGURE I

COLUMBIA - NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

MEAN ANNUAL RUNOFF IN INCHES

THE REGION

1968

FIGURE 2

Snow - natures way of storing excess winter rains to assure summer streamflows. (SCS Ida 25151).

in the summer. However, practically all of this eastern area experiences intense summer storms. Since the area is influenced considerably less by marine air, the winters are cold and the summers are hot. The growing season on agricultural lands varies from about 70 days at higher elevations to 210 days on the Columbia River near The Dalles, Oregon. At elevations above 6,000 feet, frost can occur any month of the year.

Precipitation, soil, slope, cover, and temperature are some of the major factors that affect runoff regionwide. Since these factors are highly variable and appear in many combinations, the regional mean annual runoff ranges from less than 1 inch to about 120 inches (figure 2). These conditions, combined with the past and present land use, result in the loss of several thousand acre-feet of soil annually. Estimates of these losses are summarized in table 2.

Erosion from cultivated land, land disturbed by urban construction, logged forest land, and over-grazed pasture and rangeland is the source of much sediment which greatly reduces the attraction of streams and estuaries for recreation, as well as damaging the fishery resource. There are thousands of acres of sand dunes along the coast, many of which have been stabilized, but some require attention. Wind erosion is another source of sediment that pollutes the waters.

Table 2 - Generalized Sediment Yield by Cover and Major Land Use, The Region

Cover and Land Use	Area (1,000 Acres)	Sediment Yield (Ac-Ft./Year)	Percent
Cropland	20,803.8	17,786	45
Forest Land	85,843.5	9,210	23
Rangeland	58,744.6	11,153	28
Other Land	8,323.4	1,709	4
Total	173,715.3	39,858	100

Source: Derived from Cover and Land Use Maps and Generalized Sediment Yield Maps by subregion.

Cropland

Commercial agriculture began in 1825. Hudson's Bay Company cleared and started farming operations on 2,500 acres of the Cowlitz Prairie in Lewis County, Washington. This farm provided food for settlers along the Cowlitz and Columbia Rivers for shipment to California and Alaska.

In the 141 years between 1825 and 1966, agriculture has grown from one farm with 2,500 acres to almost 135,000 farm units with just under 21 million acres of cropland (table 3). Varieties of crops grown have increased from a few staples and vegetables to a balanced variety of hay, pasture, grain, livestock, dairying, fruit, nuts, row crops, grass seed, peppermint, hops, vegetables, and a large number of other crops.

Farming is a flourishing industry because of favorable soils, climate, and markets. Although the region is generally mountainous, there are extensive additional areas of bottomlands, benches, and uplands with excellent soils suitable for crop production. Only about 58 percent of these lands are presently in cropland.

In the coastal area, dairying is the principal source of farm income, with beef production second. Cranberries, blue berries, lilies, and nursery crops, such as rhododendrens and azaleas, are important crops in some areas.

In the interior valleys of western Oregon and Washington, the largest variety of crops is grown. These include tree fruits, nuts, caneberries, strawberries, sweet corn, green beans, vegetables, hay, pasture, and many others.

East of the Cascades, a large portion of the cropland is devoted to forage production. There are also large acreages in

Table 3 - Cropland Area in Farm Units, The Region, 1966

Subregion	Number of Farms	Cropland (1,000 acres)	Average Cropland/Farm (acres)
1	12,258	1,552.1	127
2	9,806	3,308.8	337
3	6,832	686.3	100
4	17,723	3,781.3	213
5	13,395	1,628.9	122
6	7,719	3,077.8	399
7	9,011	3,570.6	396
8	5,390	201.1	37
9	21,987	1,456.1	66
10	11,886	584.8	49
11	18,576	591.0	32
12	403	365.0	906
Total	134,986	20,803.8	154

Source: Soil Conservation Service C-NPRBS Data.

Table 4 - Dryland Crops, The Region, 1966

Sub-region	Dry Crop-land Area	Forage	Grain	Fallow	Seed	Field Crops 1/	Specialty & Other
	(1,000 acres)						
1	1,087.5	506.0	304.9	146.8	-	-	129.8
2	2,601.9	162.5	1,280.7	1,158.7	-	-	-
3	196.3	0.3	98.0	98.0	-	-	-
4	1,370.9	160.5	634.3	576.1	-	-	-
5	207.9	135.0	41.2	31.7	-	-	-
6	2,810.0	192.7	1,589.2	597.2	17.0	333.7	80.2
7	3,045.2	194.1	1,422.3	1,322.1	-	100.1	6.6
8	183.8	178.2	1.5	-	1.0	-	3.1
9	1,212.1	344.1	528.1	-	269.2	-	70.7
10	409.6	394.7	8.2	-	-	-	6.7
11	499.5	392.5	12.7	32.0	-	-	62.3
12	47.8	29.9	8.4	8.3	1.2	-	-
Total	13,672.5	2,690.5	5,929.5	3,970.9	288.4	433.8	359.4

1/ Close growing field crops.
Source: Appendix IV, Land & Mineral Resources.

small grain, potatoes, sugar beets and fruit with lesser acreages of mint, vegetables, and others. Cropping patterns by subregions are shown in tables 4 and 5.

Table 5 - Irrigated Crops, The Region 1966

Sub-region	Irri.Crop-land Area	Forage	Grain	Seed	Fruit & Nuts	Row Crops	Specialty & Other
	1000 Acres						
1	464.6	391.8	40.0	--	--	--	32.8
2	706.9	331.2	134.5	--	67.4	79.4	94.4
3	490.0	116.0	59.2	--	146.3	91.8	76.7
4	2,410.4	1,052.3	667.8	2.4	--	684.7	3.2
5	1,421.0	812.1	192.4	4.0	10.9	397.6	4.0
6	267.8	204.1	43.1	5.9	--	5.3	9.4
7	525.4	414.1	28.0	--	33.2	42.0	8.1
8	17.3	11.4	--	--	0.6	2.9	2.4
9	244.0	90.5	6.9	7.0	15.7	48.1	75.8
10	175.2	144.9	13.1	--	--	--	17.2
11	91.5	80.0	0.5	--	3.7	7.3	--
12	317.2	300.0	17.2	--	--	--	--
Total	7,131.3	3,948.4	1202.7	19.3	277.8	1359.1	324.0

Source: Appendix IV, Land and Mineral Resources

Watershed Protection

In many areas soil erosion and excessive runoff have been controlled through the use of land treatment measures and other improvements. In 1954, Congress gave assistance to these local groups by enacting the Watershed Protection and Flood Prevention Act (P.L. 566). This act provides for Federal assistance to authorized organizations to carry out, maintain, and operate works of improvement for flood prevention and for the conservation, development, utilization, and disposal of water in watersheds or subwatersheds of 250,000 acres or less.

Improvement work on watershed projects includes land treatment and structural measures. Land treatment measures, the basic elements of watershed projects, are planned, installed, and maintained on privately owned land by individuals and groups or by local organizations. These measures protect and improve the soil and water resources of individual farms and ranches and, at the same time, provide the highest feasible degree of runoff retardation, sediment control, and water management.

Water Conservation

The major water conservation problems are primarily of three kinds: excess, shortage, and quality, and are related to the annual precipitation and its seasonal distribution. Since most of the precipitation is received in the winter, streamflows are at their

Table 6 - Water Conservation Practices Applied on Cropland, The Region, 1966

Sub-region	Water Control Facilities	Water Storage Facilities	Irrigation Conveyance Facilities	Surface Irrigation Systems	Sprinkler Irrigation Systems	Land Shaping	Irrigation Water Management
	No.	No.	Miles	No.	No.	1000 Acres	1000 Acres
1	927	295	3,219	813	2,620	5	99
2	10,534	87	2,575	1,812	6,274	152	160
3	7,879	111	5,936	3,883	1,784	156	176
4	79,130	127	12,320	1,780	2,200	461	842
5	34,841	182	10,334	1,855	674	363	238
6	4,337	48	749	4,730	1,550	43	49
7	23,219	106	5,083	1,988	1,806	104	113
8	717	36	9	--	504	2	10
9	57	244	36	--	3,185	40	140
10	1,934	264	407	2,787	1,586	38	39
11	286	162	18	--	2,213	8	19
12	3,480	47	1,560	7,800	127	41	16
Total	167,341	1,709	42,246	27,448	24,523	1,413	1,901

Source: USDA, Soil Conservation Service Data

highest in the late winter and early spring and at their lowest in late summer and early fall, when soils are very dry and the needs for agricultural, industrial, domestic, and other purposes are the greatest. Water quality is poorest during the dry summer periods.

In the coastal area, irrigation has developed more slowly than in other areas. On the average, about 70 percent of the moisture needed by plants is supplied by rainfall. In about one out of 7 years there is enough precipitation without irrigation.

In the interior valleys of western Oregon and Washington, irrigation is not essential for most crops but is profitable for most crops through increased yields and higher quality.

Irrigation west of the Cascades was not significant until the mid-1940's, when aluminum pipe and improved sprinkler systems became available. East of the Cascades, irrigation is necessary to produce most crops and is essential in areas with less than 10 inches of precipitation and has developed along with agriculture.

About 45 percent (3.2 million acres) of the irrigated cropland has delivery and distribution systems capable of properly supplying and applying irrigation water. However, only about 1.9 million acres are managed with acceptable efficiency. Many practices and management techniques have been applied to improve efficiencies (table 6). More than 1.8 million acres of irrigated cropland are short of irrigation water during mid and late summer periods. The availability of water and the amount and type of irrigation systems are shown in table 7.

Table 7 - Water Availability and Irrigation Methods, The Region, 1966

Sub-region	Irrigated Cropland 1/	Water Source			Water Supply		Application Method	
		Stream	Ground	Reservoir	Adequate	Inadequate	Sprinkler	Surface
	--------------------	--------------------	--------------------	----------1000	Acres----------	--------------------	--------------------	--------------------
1	464.6	310.0	41.3	113.3	275.0	189.6	138.0	326.6
2	706.9	96.0	55.4	555.5	670.4	36.5	310.7	396.2
3	490.0	261.6	17.4	211.0	387.0	103.0	98.8	391.2
4	2,410.4	599.5	654.2	1,156.7	1,953.4	457.0	464.6	1,945.8
5	1,421.0	581.5	65.9	773.6	1,040.0	381.0	115.2	1,305.8
6	267.8	221.0	10.3	36.5	144.7	123.1	78.5	189.3
7	525.4	341.6	42.4	141.4	282.5	242.9	123.9	401.5
8	17.3	12.8	4.4	0.1	15.9	1.4	17.3	--
9	244.0	117.2	100.0	26.8	223.4	20.6	240.1	3.9
10	175.2	105.6	6.5	63.1	129.6	45.6	66.5	108.7
11	91.5	55.2	34.7	1.6	91.5	--	90.4	1.1
12	317.2	278.6	14.1	24.5	47.7	269.5	5.6	311.6
Total	7,131.3	2,980.6	1,046.6	3,104.1	5,261.1	1,870.2	1,749.6	5,381.7

1/ Approximately 97 percent of Irrigated Area, Appendix IX, Irrigation
Source: Soil Conservation Service C-NPRBS Data

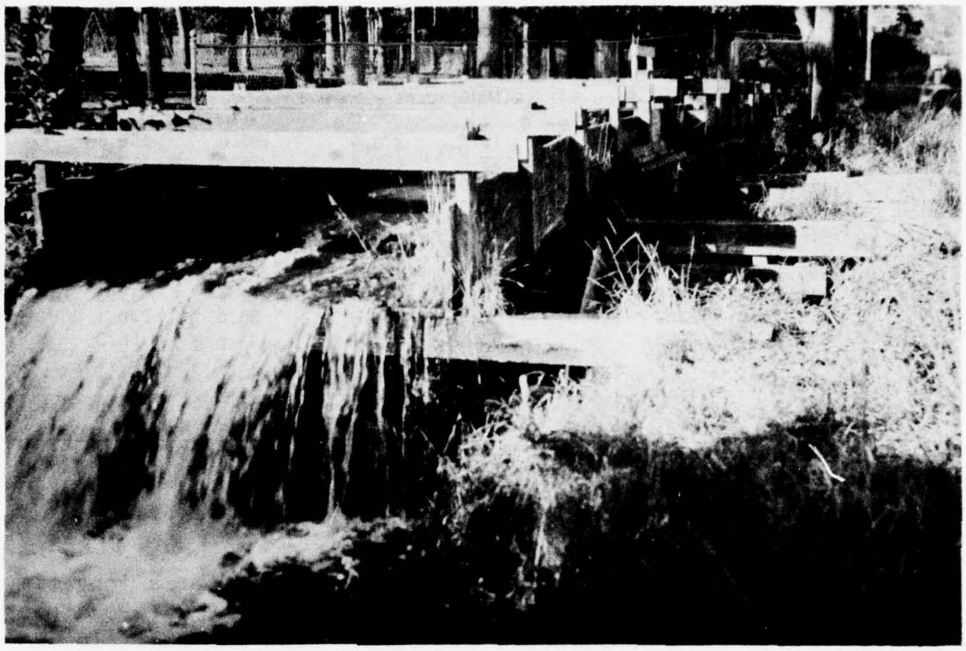
Storage ponds and reservoirs have been used for a long time to store flood waters for later use. In the region, 28,790 storage structures have been constructed on private land for multiple-purposes such as 1,709 ponds for irrigation, 13,707 for domestic uses (stockwater, fish, fire protection, and wildlife), and 12,921 for irrigation water regulation.

On dry cropland, a number of measures are installed for conserving the limited supply of natural moisture; they also provide erosion control. Some of these practices are stripcropping, stubble mulching, diversion terraces, and subsoiling.

Drainage

Draining the land to allow its continued cropping has been undertaken since the earliest farming began. Early settlers used hand-dug ditches to drain surface water from wet areas. Tile drains had been installed before 1900 and covered wooden drains were used before this in the Willamette Valley.

More than 2.5 million acres of cropland have a wetness or drainage problem. This acreage is about equally divided between the humid area west of the Cascade Range and the arid area to the east. The cropland areas with a wetness problem are presented in table 8 by subregion and capability class.



Temporary irrigation water conveyance systems require extra labor, increase farm costs, and reduce efficiency. (SCS 0-1068-10)

The wet cropland classes are defined as follows:

II - Soils having some water limitations with a slight reduction in the choice of plants or requiring moderate drainage practices.

III - Soils having severe limitations with a moderate reduction in the choice of plants or requiring special drainage practices.

IV - Soils that have a very severe limitation that restricts the choice of plants to grass or trees or requires extensive drainage practices and careful management.

An estimated 844,000 acres of cropland have been drained sufficiently for the development of current cropping patterns. Part of the remaining 1,682,700 acres of wet cropland have drainage problems, not particularly serious at this time because of the type of crops grown. Drainage practices applied on cropland through 1966 are shown in table 9.

Table 8 - Cropland Areas with a Wetness Problem, The Region, 1966

Subregion	Capability Class II	III	IV	Total
	(1,000 acres)			
1	54	38	76	168
2	30	52	25	107
3	42	42	29	113
4	14	147	235	396
5	82	91	9	182
6	1	89	61	151
7	-	13	45	58
8	86	2	-	88
9	159	133	128	420
10	52	46	94	192
11	261	187	70	518
12	3	102	29	134
Total	784	942	801	2,527

Source: Soil Conservation Service, C-NPRBS Data.

Table 9 - Drainage Practices Applied to Cropland, The Region, 1966

Subregion	Drainage Conduits (Miles)	Drainage Structure (Number)
1	983	109
2	914	254
3	1,690	858
4	226	27
5	628	358
6	1,189	73
7	606	378
8	1,505	401
9	7,167	342
10	1,506	401
11	2,445	274
12	243	2
Total	19,102	3,477

Source: Soil Conservation Service Data.

Poorly drained soils restrict land use to salt tolerant grasses and other low income producing crops. (SCS I-2741-16)

Drainage problems in the humid areas of western Oregon and Washington are mostly from excess precipitation and seepage on slowly permeable bottomland and benchland soils. Both surface and subsurface drainage are important in this part of the region.

Drainage problems in the areas east of the Cascade Range are mostly from irrigation water associated with poor water management or canal seepage. The results range from lowered productivity to abandonment for cropland use, and may also contribute to the accumulation of toxic salts.

Certain dry cropland areas have drainage problems in the form of hillside seeps, wet areas at the toe of slopes, and small areas with perched water tables.

Poorly drained soils reduce crop production in several ways:

1. Evaporation lowers soil temperature. Also, wet soil requires more heat to warm than does dry soil, because of the high specific heat of water as compared to that of soil. Thus, the growing season is shortened.

2. Saturation and surface ponding stops air circulation in the soil and prevents bacterial activity.

3. Certain plant diseases and parasites are encouraged.

4. A high water table limits root penetration.

5. Soil structure is adversely affected and root penetration diminished.

6. Salts and alkali, if present in the soil or ground water, tend to be concentrated in the root zone or at the soil surface.

7. Wet spots in the field delay farm operations or prevent uniform treatment.

8. Reduces the choice of crops.

Erosion & Sedimentation

Water erosion problems on the arable lands are of three types--gully, rill, and sheet erosion. These can occur on any land with insufficient vegetative cover, but it is more damaging in cultivated sloping lands and is most troublesome in the wheat-fallow areas. Damages are principally top soil loss, reduced productivity, and inconvenience in farm and ranch operations.

Although there are exceptions, severe bank erosion is spotty and usually occurs as the result of acute channel curvature or gravel bars deflecting currents. It is serious to individual landowners, especially along the main rivers because the problems are large in relation to the resources available to prevent or control them.

Scour erosion by overflowing floodwaters can cause serious damage to fields unprotected by vegetation. This type of damage occurs generally near the main rivers during the larger floods. Table 10 shows, by subregion, the cropland acreage susceptible to erosion.

Erosion potential by capability classes is defined as follows:

II - Soils having some limitations that reduce the choice of crops grown or require moderate application of practices to prevent erosion.

III - Soils having severe limitations that reduce the choice of crops grown or require special erosion control practices.

Table 10 - Cropland Areas with an Erosion Potential by Capability Class, The Region, 1966

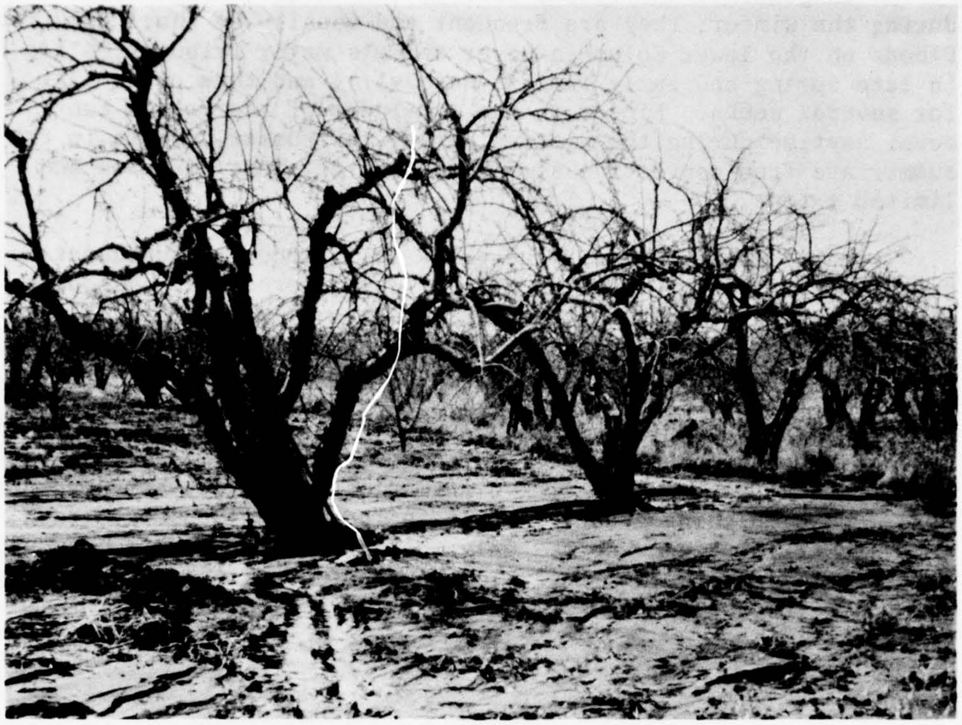
Subregion	II	III	IV	Total
	-----------1000 Acres-----------------			
1	74	255	963	1,292
2	385	1,825	313	2,523
3	97	187	213	497
4	371	1,445	387	2,203
5	202	366	295	863
6	308	1,803	550	2,661
7	93	739	1,199	2,031
8	47	14	1	62
9	146	274	300	720
10	69	133	395	597
11	--	43	251	294
12	8	25	49	82
Total	1,800	7,109	4,916	13,825

Source: Soil Conservation Service, C-NPRBS Data

IV - Soils having very severe limitations that limit the choice of crops to grass and trees unless extensive use is made of erosion control practices and careful management is exercised.

Erosion varies with soil condition, cover, and precipitation. Most of the eroded material is deposited in the same field from which it erodes. However, part of the sediment, including expensive items such as fertilizers, seeds, herbicides, and insecticides, is deposited in roadside ditches, culverts, canals, and natural streams that must be removed at considerable expense.

Sedimentation is one of the most serious seasonal problems of water quality. Soil conservation practices and changes in land use are important means of reducing the sediment loads transported by our streams. Proper land treatment practices applied on the high sediment producing agricultural lands could reduce sediment yields by as much as 90 percent. Structural measures such as debris basins may reduce sediment yields by an even higher percentage. The total accomplishments in cropland erosion control practices applied through 1966 are presented in table 11. While the erosion problem has been alleviated on considerable acreage, there presently remain 5.7 million acres of cropland which still have erosion problems requiring additional attention.



Sedimentation in orchards reduces yields and in severe cases destroys trees. (SCS W-1537-8)

Table 11 - Erosion Control Practices Applied on Cropland, The Region, 1966

Sub-region	Grade Stabilization Structures	Diversions & Terraces	Field Wind-break	Crop Residue Use	Stubble Mulch	Grassed Water-ways	Strip Cropping	Conservation Cropping Systems	Grass and Legume Seeding
	No.	Miles	Miles	1000 acres					
1	146	42	12	491	72	5	12	567	152
2	402	49	233	1,239	633	3	16	1,488	134
3	9	10	17	209	83	1	3	250	63
4	187	15	305	862	233	3	14	1,372	137
5	1,226	14	9	311	7	--	5	508	69
6	80	349	41	1,343	233	7	69	1,120	114
7	82	866	225	740	570	29	156	428	160
8	21	2	--	23	--	14	--	104	41
9	13	26	--	382	--	3	--	555	77
10	33	28	--	40	--	1	--	120	95
11	9	--	1	32	--	1	--	211	5
12	184	50	2	32	6	--	6	38	24
Total	2,392	1,451	845	5,704	1,837	67	281	6,761	1,071

Source: Soil Conservation Service Data

Flooding

Causes, characteristics, and average annual damages of floods and storage and flood management are emphasized and described in Appendix VII, Flood Control. The emphasis in this appendix, to avoid duplication, will be toward those practices that are more closely related to the land and watershed protection.

In general, the floods west of the Cascade Range occur during the winter; they are frequent and usually of short duration. Floods on the lower Columbia River and its major tributaries are in late spring and early summer (May-July), and they often last for several weeks. Floods in the remainder of the region can occur anytime during the winter, spring, or summer. Those in the summer are from convective storms and are of short duration and limited extent.

Late spring, summer, and early fall floods are devastating because they destroy crops as well as damage cropland. Frequent flooding often prevents development and intensive farming.

Most land and watershed protection measures have multiple objectives and benefits. Many measures listed previously, whose main purpose may be for water conservation or erosion and sedimentation control such as water storage facilities, conservation cropping systems, conservation planting of all kinds, stripcropping, and stubble mulching greatly assist in reducing floods by either delaying or reducing runoff. Only the measures applied whose main purpose is flood control and which have not been listed previously are shown in table 12 and in similar tables in each of the subregions.

Table 12 - Flood Control Measures Applied on Cropland Areas
The Region, 1966

Subregion	Stream Channel Improvement	Streambank Protection	Stream Channel Stabilization	Dikes & Levees
	-----	-----	Miles	-----
1	124	44	8	24
2	180	48	2	4
3	123	11	21	19
4	70	20	17	51
5	157	31	8	46
6	229	24	2	21
7	338	49	3	40
8	59	136	13	128
9	265	18	--	105
10	311	122	4	114
11	87	41	5	273
12	53	26	1	51
Total	1,996	570	84	876

Source: Soil Conservation Service Data

At the present time, flood problems exist on an estimated 2.3 million acres. Of this amount 1.6 million are used for crops. The average annual damages have been estimated to be $69.1 million.

Forest Land

Forests cover over 85 million acres or nearly 50 percent of the total land area in the Columbia-North Pacific Region. Nearly 65 percent, largely in the headwaters and high mountains, is in public ownership. The remaining 35 percent is owned by either the forest industry or small landowners. Of this, 82 percent is currently classified as commercial forest land. The other 18 percent is noncommercial, either because it is found on adverse sites or has been excluded from timber harvest by statute or administrative order. The detailed breakdown of these timber types, by ownership, is found in Appendix IV, Land and Mineral Resources.

Commercial forests constitute a basic resource, vital to the economic and esthetic well-being of the population. These forests supply the raw material for the region's forest products industry, a key industry that furnishes nearly 40 percent of the total regional manufacturing employment. The region, in turn, contains almost 15 percent of the Nation's wooded areas and half its sawtimber volume and, for the past 10 years, has been producing almost half the Nation's softwood lumber.

In 1964, almost 21 billion board feet of timber were harvested from the forest lands of the region. About 7.4 billion board feet came from the national forests, the 13.6 billion foot balance from other public and private lands. This timber was harvested by many combinations of logging practices. They included cable and tractor systems and even experimental balloons.

Of the 239 million acre-feet of runoff generated in the region, 87 percent, or 205 million acre-feet, originate in forest areas. Nearly 3 million people, representing 84 percent of the urban population, depend, in part, on these forested watersheds as a source of their domestic water. Also, almost 30 million acre-feet are withdrawn annually for irrigation purposes. Many forested areas are extensively used by both domestic livestock and wildlife. These areas amount to nearly 29 million acres and support 26 percent of the total grazing capacity. The noncommercial juniper-grasslands types are some of the better grazing lands in several subregions.

Forest lands provide the environment for a substantial portion of the region's outdoor recreation, containing vast areas for hunting, fishing, camping, sightseeing, and a host of other outdoor activities. Estimates (1965) indicate that some 43 percent of the outdoor recreation use was on forest land.

Land use activities usually accelerate erosion, and man's failure to recognize the consequences has led to serious resource waste and depletion. Therefore, management and development of the forest resources must fully recognize the need for watershed protection. Appropriate measures must be taken, concurrent with utilization, to maintain or enhance soil and water values. At those locations, where values have been largely neglected in the past, rehabilitation measures designed to stabilize soil and improve water quality must be utilized.

Present Watershed Situation

The forested watershed lands are, with local exceptions, generally in a good hydrologic condition. These lands make up 50 percent of the total land area, but contribute only 23 percent of the total sediment (table 13). This is generally true since forest lands, with an undisturbed cover condition, yield less sediment than agricultural lands where the vegetative cover is disturbed annually by cultivation. Sediment production varies greatly between subregions. Precipitation, runoff, and soil have a greater influence on sediment yields than the vegetative condition of the watershed. Thus, the wetter forest areas produce more sediment than the drier areas if the vegetative conditions are equal, because there is more runoff to transport it.

Perhaps the most widespread and severe land use impact results from timber harvest and related activities. Soil and vegetative disturbance associated with road building and log skidding have in the past and continue to be a threat to water quality. Poor management practices have been responsible for streamflow impairment, unnecessary soil movement, excessive siltation and general reduction in water quality. Current management practices on public forest land consider this problem and plans include measures to protect the watershed values. Land management practices on private forest land also protect watershed values.

Extensive timber access road systems are required to facilitate removal of timber to the mills for processing. These roads receive extensive additional uses, such as furnishing access for fire control purposes, hunters, fishermen, campers, and other forest user activities. To safely handle both logging and other traffic, roads must be wide enough to permit vehicles to pass safely and have grades that permit heavily loaded trucks to travel

Table'13 - Present Sediment Yield, Forest Land
Columbia-North Pacific Region

Subregion	Forest Land Acre-feet Per Year	Forest Land Percent	Non-forest Land Acre-feet Per Year	Non-forest Land Percent	Total Acre-feet Per Year
			COAST, CASCADE AND ROCKY MTN. AREA		
1	1,366	37	2,284	63	3,650
6	1,226	11	10,404	89	11,630
8	423	79	109	21	532
9	840	45	1,017	55	1,857
10	2,187	92	190	8	2,377
11	1,013	63	586	37	1,599
	7,055	33	14,590	67	21,645
			COLUMBIA - SNAKE INTERMOUNTAIN AREA		
2	548	21	2,103	79	2,651
3	202	39	320	61	522
4	262	8	2,841	92	3,103
5	575	12	4,360	88	4,935
7	509	8	5,569	92	6,078
12	59	6	866	94	925
	2,155	12	16,059	88	18,214
			REGIONAL TOTAL		
	9,210	23	30,649	77	39,859

Source: Summarized from subregional maps and tables.

efficiently. High standard alignment and grade require rather extensive earth movement. Even when properly located and built, these access roads occupy a significant portion of the landscape.

Although logging and associated activities have the most significant impact on forest watersheds, other uses contribute to sediment loads if not carefully administered. Overused recreation areas become barren, compacted, and vulnerable to severe erosion. Overgrazed livestock and wildlife ranges are sediment contributors. The mining industry adds sediment to streams during exploration, development, and operation. Access roads associated with powerline construction through rough, mountainous forest lands are frequently steep and, when poorly drained, result in water concentration and soil movement.

Nearly all land use activities on the forested watersheds can disturb the vegetation and soil, concentrate water, or interrupt natural drainage patterns, and result in soil loss, water quality reduction, and downstream siltation. Daily, more and more acres come under the influence of these activities and bring the significance of the role of watershed protection practices on present and future water quality more sharply into focus.

The Coast, Cascade, and Rocky Mountain Forest Area This timber area, making up about 45 percent of the region, includes that part west of the Cascade Mountains in Washington and Oregon and most of northern Idaho and western Montana. The subregions in this area currently produce the highest sediment yields from forested lands (table 13). Over 7,000 acre-feet of sediment per year representing 77 percent of the total yield from all forest land come from these subregions. Table 14 contains a classification of the watersheds of this area according to sediment yield levels. The low and very low categories generally cover areas of moderate to high inherent stability with low geologic erosion. The medium to very high categories are those areas yielding higher levels of sediment due to a combination of accelerated land use activities, unstable soils, and greater geologic erosion activity (table 14).

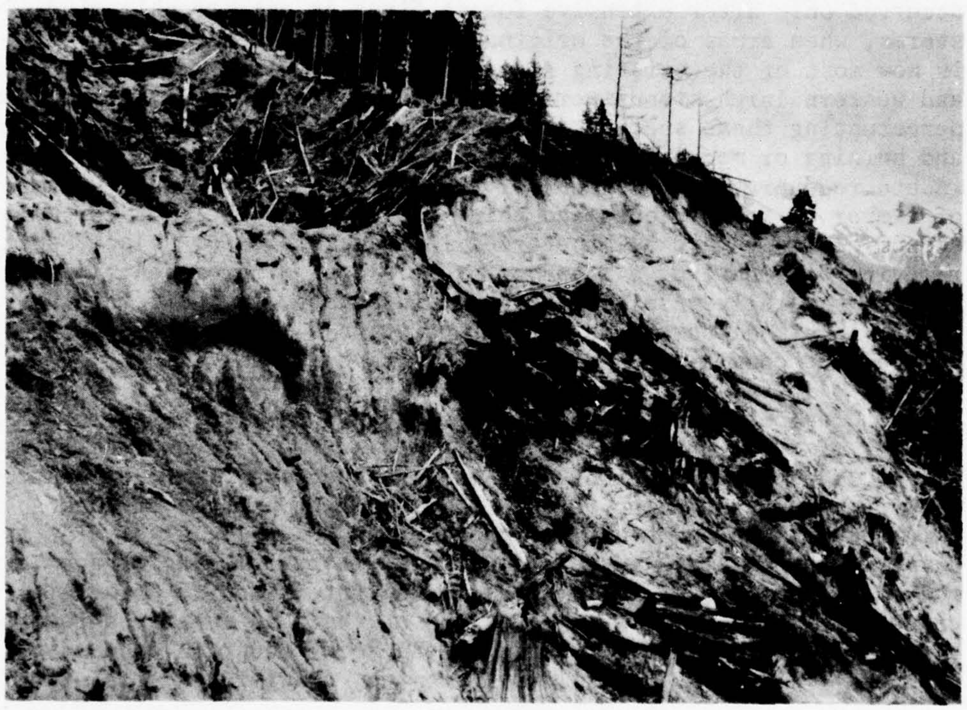
Table 14 - Present Sediment Yield, Forest Land--Coast, Cascade and Rocky Mountain Forest Area, Columbia-North Pacific Region

Sediment Yield Category	Acres (1,000)	Percent	Annual Sediment Yield: Acre-feet Per Square Mile	Annual Sediment Yield: Total Acre-feet	Percent
Very low	27,597.4	46.0	0.02 - 0.1	863	12
Low	29,388.8	49.0	0.1 - 0.2	4,592	65
Medium	2,017.1	3.4	0.2 - 0.5	630	9
High	835.2	1.4	0.5 - 1.5	653	9
Very high	135.0	.2	1.5 - 4.0	317	5
Total	59,973.5	100.0		7,055	100

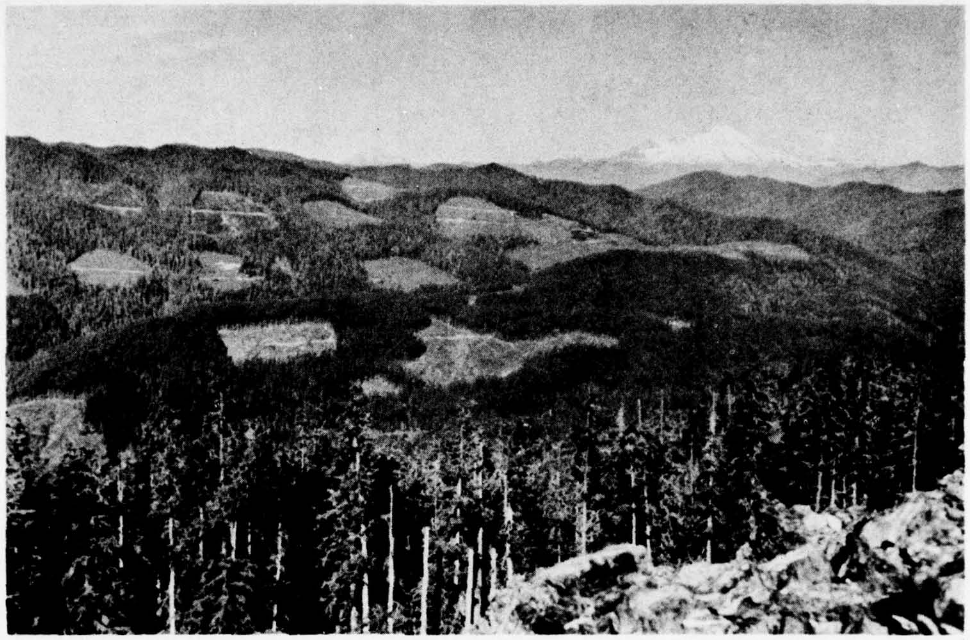
Source: Summarized from subregional maps and tables.

In these western and northern subregions, timber is generally harvested in clearcut blocks. All merchantable trees are removed in one operation. There are two principal reasons for this type of management practice: (1) The tree species most desirable for both quality and growth characteristics are intolerant to shade and cannot be reproduced with any degree of dependability without open ground, sunlight, and exposed or mineral soil. In nature, this

Properly located and designed timber access road in the Pacific Northwest. (Forest Service)



When improperly located, access roads cause a tremendous impact on the landscape. (Forest Service)



Timber harvest cutting blocks typical of the Cascades area of the Columbia-North Pacific Region. (Forest Service)

occurred only after extensive forest fires or catastrophic wind storms, when areas of the original forests were destroyed. That is how most of the existing stands of Douglas-fir, lodgepole pine, and western larch stands were established. Forest managers are now perpetuating these species through block cutting old growth timber and burning or mechanical scarification to expose mineral soil and induce regeneration; (2) most of these areas support heavy volumes of timber on steep slopes and thin soils. Not only is it far more economical to remove all the trees in a small area or "block," but removing only part of a stand on steep slopes with present logging systems generally results in significant damage to the remaining trees. Slash disposal and site preparation costs under these partial-cut conditions are also prohibitive at this time.

Clearcut areas are generally logged by utilizing one of a variety of cable systems designed to handle timber economically and to reduce the amount of soil movement necessary in the construction of tractor skidding roads. The resultant pattern of the cable skid roads, fanning outward as they spread downhill, also helps to disperse runoff over wider areas. This water spreading effect reduces the chance of gullying by concentrated runoff. Mobile cranes operating from fixed locations on the road sometimes replace the tall spar tree, particularly in the Rocky Mountain area where the trees are generally smaller. Here too, crawler tractors are

High-lead logging in the Pacific Northwest. (Forest Service)

utilized to salvage scattered dead and down timber, or to harvest clearcut areas when the terrain permits.

In the timber felling process, all trees in the cutting area must be felled. This includes large, small, living, and dead trees. Although the merchantable logs are brought in to the road, some debris, snags, and cull logs are left behind. They sometimes plug small stream channels, causing debris dams that catch lightly floating material and silt. Such plugs frequently wash out during periods of high runoff, causing severe downstream damage. This is also detrimental to fishery values, especially if the channels are used for spawning purposes. Removal of this debris constitutes an important phase of the yarding and cleanup operation.

The Columbia-Snake Intermountain Forest Area This timber area covers that part of the region east of the Cascade Mountains in central Washington and Oregon and the Snake River Plains in southern Idaho. The 2,155 acre-feet of sediment per year represent 23 percent of all sediment contributed by the forest land. Lower precipitation levels, less runoff, and more moderate terrain are the primary reasons for the lower erosion rate. However, high intensity summer storms can cause high yields of short duration. Table 15 classifies the area according to sediment yield levels.

Skidding in the Northern Rocky Mountains. (Forest Service)

Table 15 - Present Sediment Yield, Forest Land, Columbia-Snake Intermountain Forest Area, Columbia-North Pacific Region

Sediment Yield Category	Acres (1,000)	Percent	Annual Sediment Yield: Acre-feet Per Square Mile	Annual Sediment Yield: Total Acre-feet	Percent
Very low	16,555.5	64.0	0.02 - 0.1	517	24
Low	8,323.2	32.1	0.1 - 0.2	1,300	60
Medium	969.5	3.7	0.2 - 0.5	303	15
High	10.9	.1	0.5 - 1.5	9	-
Very high	10.9	.1	1.5 - 4.0	26	1
Total	25,870.0	100.0		2,155	100

Source: Summarized from subregional maps and tables.

Ponderosa pine is the predominant timber species found in this area and grows in relatively sparse stands on moderate topography. Because of uneven-aged stand conditions, most of the timber is harvested by a tree selection, partial-cut method. Individual trees or groups of trees are marked, felled and usually skidded to truck roads by crawler tractor or mobile yarder.

Since timber stands are open and topography is generally not too steep, crawler tractors and mobile yarders can safely be used. Where the slopes are steeper, the tractors are replaced by mobile cranes. These require a more extensive spur road system, but total ground disturbance is about the same.

Generally, the problems associated with the timber harvest, whether using the cable or tractor system, are similar. All cause additional surface disturbance through road construction and log movement, add debris in stream channels, and may cause marked increases in stream water temperatures.

Watershed Protection Practices

Protection practices are used in conjunction with on-going forest land uses, whether for timber harvest, grazing, recreation, or other purposes. The extent to which these practices are employed during and after a particular use depends largely on the short and long range management goals of the various landowners.

Public Forest Lands The public forests, principally the national forest, Public Domain, and State lands are almost always managed according to multiple use principles. This means that a resource, such as timber, can be utilized, but not at the expense of other resources, such as water. Accordingly, certain practices designed to protect the water resource are required as standard operating procedures in timber harvest operations.

As part of the timber harvest operation, soil disturbance is kept to a minimum and disturbed areas left in a stable condition. This involves construction of cross-drains or water bars on skid trails, fire trails, and temporary roads, designed to redistribute surface runoff and prevent gullying and soil movement. These trails and roads are seeded to grass to further stabilize exposed soil. To minimize soil movement, tractor skidroad grades should not be steeper than 25 percent.

Restrictions on harvest activities to protect soil and water resources include such requirements as prohibiting the falling and yarding of timber across live streams, restricting tractor operations within specified distance of live streams and in the crossing of live streams without temporary bridges. Debris accidentally falling in streams is removed as the operations progress. In areas where these streams support anadromous or native fish populations, a strip of timber is left unharvested along the streambank to keep falling and yarding operations away from the watercourse. The timber's shading effect helps to maintain lower stream temperatures which are necessary for fish survival. This practice also benefits the recreationist by maintaining a pleasing environment.

Harvest unit layout that allows for streamside protection. Note the timber strips along this anadromous fish stream. (Forest Service)

The same protective considerations apply to access road construction, which is the source of a significant amount of the total sediment occurring from forest lands. Road locations and standards are designed to minimize soil movement. Grades are limited, cut and fill slopes mulched and seeded, culverts required at specified intervals, and gravel surfacing required on most system roads. Maintenance activities such as surface blading, ditch clearance, and culvert cleaning are a vital part of good watershed management and protection.

Another practice related to watershed protection is the disposal of slash following logging. Some slash is simply scattered; however, most is burned. Either method reduces both the fire hazard and risk of insect buildup. Scattered slash also acts as a mulch while returning organic matter to the soil.

On other public forest lands, most of the recommended measures are either presently being applied or are being introduced. Although little seeding and mulching are presently done on Public Domain or State logging roads, these practices are beginning to be applied in critical areas. Certain main-line haul roads on the Oregon

and California revested railroad grant lands in western Oregon are being paved to reduce sediment loss from the roadbed. Seeding of burned areas is presently undertaken, but this type of work is just getting underway on logged-over lands. Stream clearance work is conducted on nearly all public forest lands, particularly where an anadromous fishery resource is involved.

Private Forest Lands Larger industrial forest landowners seldom employ measures designed specifically for watershed protection. However, watershed benefits do accrue as byproducts of the general forest utilization. For example, road grades are kept to reasonable levels, not only to protect the soil and water but also to reduce log transport and road maintenance costs. Culverts are used primarily to protect road investments and surfacing is used to reduce hauling costs and extend the hauling season. Although not specifically designed to protect watershed values, these measures do reduce erosion.

The "Cooperative Forest Management Programs" and the "Agricultural Conservation Program" are used to provide small woodland owners with technical and financial assistance in forest land management. The former operated under the general direction of the State Forester's Office provides technical advice on forest management problems and provides services and inspection for the ACP forest practices. The Department of Agriculture's Agricultural Conservation Program shares about 50 percent of the cost with the small forest landowner on such forest management practices as tree planting, seeding, stand improvement, and others. Critical-eroding-area treatment can also be applied on private forest lands under the Watershed Protection & Flood Prevention Act, Public Law 566. The economic benefits of some watershed protection practices are long term and produce no immediate cash returns. Accordingly they are given low priority for investment.

The average annual acreage now treated during and after timber harvest operations on both public and private forest lands is shown in table 16.

An example of some of the newer equipment used to seed and mulch forest roadside areas in the region. (Forest Service)

Table 16 - Average Annual Timber Harvest Activity,
Columbia-North Pacific Region

	Unit	Public	Private	Total
Harvest Area	Ac.	459,000	385,500	844,500
Area Reforested 1/	Ac.	247,400	176,700	424,100
Slash Disposal Area	Ac.	236,000	90,000	326,000
Disturbed Area Treated 2/	Ac.	37,900	--	37,900
Harvest Road Required	Mi.	2,525	2,375	4,900
Harvest Road Treated 3/	Mi.	1,860	170	2,030

1/ Includes planting, seeding and site preparation. Balance adequately stocked or requires no regeneration work.
2/ Includes seeding, mulching, debris removal, and cross-draining skidroads and logging areas.
3/ Cut and fill stabilization only.

Watershed Rehabilitation Practices

Public Lands Watershed rehabilitation programs are generally directed toward repair of damage resulting from early day utilization of a single resource by interests that placed little value on associated resources. Less frequently, restoration programs are directed toward reduction of sediment from natural causes such as eroding streambanks or landslide activity.

Present practices utilized to repair damage from manmade and natural causes include installation of gabions, cross-draining abandoned roads and trails, installation of debris basins and gully plugs, terracing or contour trenching and furrowing, debris removal, and numerous revegetation measures. In restoring areas of mining activity, leveling and revegetation are the common practice.

In addition, certain land treatment practices are conducted periodically on areas adjacent to hydroelectric, flood control, and irrigation storage projects. These include soil and stream channel stabilization work, snag and stump removal, and reservoir sweeping. The stabilization measures reduce sediment moving into the reservoir, thus extending its effective life while snag, stump, and debris removal enhance its recreational value.

Areas contributing sediment on public forest lands are being restored as rapidly as funds permit. Table 17 lists the present average annual watershed rehabilitation work conducted on these areas; but, except as noted, does not include on-going work generated by current timber sale activities nor current fire rehabilitation.

Table 17 - Average Annual Accomplishment
Watershed Rehabilitation Practices, Public Forest Land,
Columbia-North Pacific Region

Practice	Unit	National Forest 2/	Public Domain	Indian Lands	State Lands 3/
Sheet Erosion Control	Ac.	7,095	1,505	7,580	5
Gully Stabilization	Mi.	248	--	--	--
Stream Clearance & Stabilization	Mi.	435	37	68	13
Existing Road & Trail Rehabilitation 4/	Mi.	1,423	69	245	26
Reservoir Protection	Ac.	13,355	--	--	--

1/ Average of period 1964-66.
2/ Accomplishment to date principally on active timber sale areas (table 16).
3/ Includes abandoned roads.
Source: Data furnished by agency as listed.

Wildfire, as opposed to controlled slash disposal, can be a serious impact on forest areas. To reduce the opportunity for subsequent erosion, burn rehabilitation is undertaken immediately following suppression action. This work generally consists of revegetation by seeding or tree planting, snag falling, stream cleanout, and a host of other rehabilitation practices. Fire control lines, for example, are cross-drained as a part of the fire suppression job. This is the case whether they are constructed by hand or by bulldozer. This work is considered nonrecurrent. However, since it varies greatly from year to year, depending on the fire season, the accomplishment is not annual in nature and therefore not included in table 17.

Private Lands Because of heavier harvesting on private lands, they probably were responsible for more watershed damage than public lands. Also, administrative controls finally instituted on public lands did not affect private land operations. While less effective practices were recognized and stopped on public lands and funds appropriated to restore damaged areas, these practices often continued on private land. In addition, there was little interest to repair damaged private lands nor legislation requiring protective measures. Sometimes these areas are left to heal naturally and in the meantime continue to contribute a significant amount of sediment to the watercourses.

Burn restoration work on private forest lands is often limited to the work necessary to protect the landowner's immediate property or interests. Where mixed ownerships are involved, this problem becomes extremely complex. Where life and property are threatened, one solution is the use of Federal funds under Section 216 of the Flood Control Act of 1950. This act provides cost sharing by Federal, state, and local governmental agencies with private landowners to accomplish this work. In 1967 and 1968, the 11,000 acre The Dalles Watershed burn and 28,000 acres within the Ardenvoir and Fourth of July Mtn. burn were treated to prevent downstream flooding by reestablishing the vegetative cover of the watersheds.

Water Yield Improvement

Water yield improvement is a process of attaining desirable changes in stream regimes, water supply or water quality through manipulation of the environment, land treatment measures, or other means. There are many ways of accomplishing water yield improvement; the most economical being (1) manipulation of vegetation to reduce evapotranspiration, (2) manipulation and orientation of overstory vegetation to increase snow accumulation and reduce snowmelt rates, (3) the construction of artificial barriers to increase snow accumulation, and (4) applying land treatment measures

designed to increase infiltration rates and reduce oversurface waterflows. The results of these practices may be measured in terms of increased amounts of water, better regulated streamflows and reduction in sedimentation. Water yield improvement practices conducted on areas with deep forest soils having at least a moderate amount of precipitation usually produce the greatest effects.

Some potential exists for improving water yields in most subregions. Because techniques to be applied to meet a specific need must be tailormade to fit the precipitation and landscape characteristics, it is difficult to generalize the effects that may occur. However, a long history of research effort has confirmed that improvement of water quantity and stream regime is feasible in certain combinations of soils, vegetation, and climate.

Of the many factors affecting streamflow, vegetation plays a significant role and is one of the few factors that can be manipulated by man. Accordingly, dense stands of vegetation in high precipitation zones lend themselves well to water yield improvement projects.

Manipulation of vegetation can make more water available for streamflow and to underground aquifers in two ways. One is to reduce evapotranspiration by vegetation removal or converting from deep-rooted species to shallow-rooted species. Another is to change the pattern of overstory vegetation to induce snow accumulation or to hasten or retard snowmelt rates, depending on the treatment applied.

Cover manipulation opportunities vary greatly between subregions. Table 18 lists a few examples obtained by vegetative manipulation in some areas within the western United States. The increases shown are based on treatment to maximize yield. Less removal of the vegetation would result in less increase. Present findings indicate these increases may taper off considerably after logging, especially as the area is revegetated.

Table 18 - Water Yield Increases from Cover Manipulation
Western United States

Area	Vegetative Type	Percent of Increased Runoff
North Idaho	White Pine	32
Colorado	Lodgepole Pine	26
Oregon Cascades	Douglas-fir	40
Arizona	Ponderosa Pine	45

1/ Potentials are based on removing vegetation in a manner that will produce maximum water yields.

Conversion of brush lands to grass and conversion of deep-rooted species and riparian vegetation to plants that consume less water may increase water yields. However, because such areas are either limited in acreage, are located in low-precipitation zones with high evapotranspiration rates, or are areas of shallow soils, the potential for water yield improvement is not as great as in the forested areas. Phreatophytes (common water-loving plants), even though not abundant, consume a proportionately higher amount of water than do other types of vegetation. Some of this water may be economically reclaimable or made available for more desirable types of vegetation. Undesirable phreatophytes may be removed by uprooting, mowing or spraying with growth-retardant chemicals. An alternate method of controlling or eliminating them is to remove the water by draining marshes or pumping wells, lowering the water table to a point below the root zone.

Alpine snowfields are an important source of summer streamflow. Studies have shown that the size and depth of the snowfields are related to the size, shape, and orientation of the barrier behind which they accumulate. In many alpine areas, natural snow catchments are filled early in winter and, once these are filled, the windborne snow of subsequent storms is swept across the gently undulating snow surface to be deposited in the timber farther down the mountain. Artificial barriers can be constructed at these sites to induce additional drifting. This storage of water in high-altitude snowfields rather than in low-altitude reservoirs can result in a net reduction of evaporation.

Research and operational application of artificial snow barriers has indicated that, under specified conditions, a mile of snow fence will cause up to 50 acre-feet more water content to be accumulated in the affected snowpack than would be on the site normally. Breaking off cornices and inducing avalanches with subsequent accumulation of deep, protected drifts can also reduce evaporation losses and prolong snowmelt. One mile of cornice in the Colorado Rockies was estimated to contain 150 acre-feet of water after snow had disappeared from the surrounding areas.

Another water yield improvement method is that of water spreading. This is the practice of diverting springtime peak flows to areas having suitable soil or other underground storage capacity. Some water yield improvement benefits accrue from normal timber management practices. The timber harvest program reduces the old-growth canopy by some 800,000 acres annually. For a period of time after logging, before these areas become fully stocked and the root zone becomes fully occupied, increased streamflows can be expected due mainly to the reduction in evapotranspiration.

Normal silvicultural practices, particularly thinning, also have some temporary effect on water yield by increasing summer

low flows. Here again, this increase can be explained by reduction in losses through evapotranspiration.

Because forested lands must be used for several purposes, maximizing the opportunities will seldom be attained. Accordingly, whether the objective is extending base flows, reducing peak flows, or increasing total yield, the combined impact by either resource needs and uses will result only in optimizing the resource mix rather than achieving the ultimate for any particular resource or use.

Rangeland

The Columbia-North Pacific Region has 58.7 million acres of rangeland accounting for 34 percent of the total land area. (Another 28.9 million acres of forest land, 16 percent of the region, provides forage for domestic livestock use or has potential for forage production. Watershed problems and practices for the forest range are included in the forest land sections of this appendix.) Sagebrush is the predominant cover on 37.4 million acres or 64 percent of the range; 17.5 million acres or 30 percent is grassland; and other brush and shrubs cover the remaining 3.8 million acres. About two-thirds of the rangeland is located in the Snake River Plains and the Harney Basin (Subregions 4, 5, and 12); another one-fifth is on the Columbia Plateau of central Washington and northeastern Oregon. Rangeland acreage and ownership are discussed in Appendix IV, Land and Mineral Resources.

The Federal Government has jurisdiction over 35.7 million acres or 61 percent of all rangeland. This includes 24.3 million acres administered by the Bureau of Land Management; 6.7 million acres by the Forest Service; 1.6 million acres managed in trust by the Bureau of Indian Affairs; and 3.1 million acres by other Federal agencies. Privately owned rangeland amounts to 19.9 million acres (34 percent of the total), and the remaining 3.1 million acres are in state or local government ownership.

Watershed Management Objectives and Problems

Rangeland watershed objectives include establishment and maintenance of optimum vegetation for watershed protection; control and adjustment of livestock and game use to the grazing capacity of the range, particularly on critical watershed areas; and rehabilitation of damaged watersheds.

Problems relate to both physical characteristics of the soil and plants, and to the past and present use. When settlers first occupied major rangeland areas of the region, the lands were

On steep slopes such as this, erosion and sediment damage will be serious without immediate rehabilitation treatment. (Bureau of Land Management)

generally in excellent condition. Range plant communities had evolved without the presence of grazing animals, except for the relatively small indigenous populations of Rocky Mountain elk and American bison, which placed only light grazing pressure on the range. Completion of the railroads provided access to eastern beef markets and large trail herds were moved into the region from California, Kansas, Texas, and other areas. Desirable range plants were overused and, unable to maintain vigor and reproduce, were finally replaced by undesirable weed species. Range deterioration was further intensified by drought and frequent wild fires. Inferior plant cover and depleted residues restrict or retard moisture infiltration and retention, and allow soil deterioration, excessive runoff, and erosion.

In the early 1900's, midwestern livestock began to compete for eastern markets and there was a resulting decline in livestock on the region's rangeland. However, it was not until about 1930 that effective control of livestock use or range resources was begun. Since then, there has been a gradual improvement in the soil cover through improved grazing management and rangeland treatment to rehabilitate and protect the watershed. Because desirable native range plants are highly sensitive to grazing pressures, an extremely important part of range rehabilitation projects is the introduction of range species adapted to the area and capable of maintaining themselves in a grazing environment.

Range Management One major problem in range management is the cyclic weather conditions. Most managers try to stock for optimum forage use. In average or above average years, this stocking rate may provide safe use. However, during droughts, stockmen often elect to overgraze the range rather than reduce their herds. It sometimes requires 5 to 10 years to overcome this depletion.

Another management problem is the improper balance of seasonal ranges. In parts of eastern Oregon, the grazing capacity of areas suitable for summer use is only half that of spring and fall ranges. In eastern Washington and southern Idaho, there is a serious shortage of spring range that has been partly alleviated by thousands of acres of range seeding. Throughout the region, there is a relative shortage of range suitable for winter use. Seasonal variations pose serious management problems in allocating grazing use for optimum safe use of all range forage resources.

Proper handling of livestock to improve distribution has required the development of a number of water sources and construction of many miles of fence. This permits use of more efficient grazing systems and allows exclusion of livestock from areas that have been overgrazed, seeded, or eroded. Yet, on many summer ranges and on most spring-fall ranges, especially those in southern Idaho and southeastern Oregon, there are still insufficient or poorly distributed stock watering facilities. This causes a concentration of grazing near existing watering places, while forage several miles distant is not adequately utilized.

Imbalance of big game numbers with forage production presents the same problems as livestock use. On many winter ranges and on some summer ranges, numbers of big game may exceed forage supply, causing range deterioration. The needs of big game for forage have not been fully evaluated in estimating grazing capacities for the range; there is direct competition for forage on about 10 to 15 percent of the total range area where big game and livestock graze the same key areas.

Erosion and Sedimentation Severe accelerated erosion occurs on some ranges. In portions of eastern Oregon and eastern Washington, and parts of the Snake River Plains, highly productive mountain meadows have been incised by gullies up to 20 feet in depth. This lowers the water table, which must be restored before full capacity forage production can be regained. In other range areas, especially in sandy soils near the Columbia River and in sections of southwestern Idaho, overgrazing, recurrent fires, and attempt at cultivation have initiated severe wind erosion, causing sand dunes, lowering the productivity of the immediate area, and threatening adjacent lands. On some ridge tops in the Blue Mountains of northeastern Oregon and southeastern Washington, erosion of the initially

shallow soil mantle has proceeded so far that the topsoil is gone, greatly impairing infiltration and forage productivity. In mountainous, granitic areas of southwestern and central Idaho, erosion and depletion have caused the soils on steep ridges and south slopes to become unstable, producing excessive and damaging storm runoff and lowering the forage productivity. The effect of erosion in the immediate area is the loss of soil cover, decreased infiltration, and increased damaging runoff. Of perhaps more importance are the downstream effects. These include reduction in water quality, damage to cropland, urban areas, ditches, and roads, and sediment in salmon spawning beds.

Water and Range Use Water is an important consideration on all rangeland. In many areas, especially the more mountainous or hilly locations, water retention and water yield values far exceed forage production values. Some ranges, where soils are derived from granite or sandstone, are so unstable or steep that even minimal grazing use has damaged watershed values. Rangeland management has a marked effect on the water supply, particularly on water quality. Effective management on an increasingly larger part of the range now contributes both to good forage and to good water quality and quantity by maintaining a satisfactory vegetation cover. In other areas where livestock and big game use have not been controlled, cover and soil conditions continue to deteriorate, resulting in a decline in water quality, wider variation in rates of runoff, and more erosion and sedimentation.

Flooding Flooding generally has no serious adverse effect directly on rangeland areas. However, rapid runoff from deteriorated rangeland contributes substantially to downstream flood damage. High water or spring runoff in most streams and rivers is generally caused by snowmelt and accompanying spring rains. This occurs on main rivers in the spring and higher elevation streams in early summer. Relatively infrequent but disastrous cloudburst storms sometimes occur in the summer. Improved rangeland management practices and measures for increased soil stability can have a pronounced effect in reducing flood damage during these critical periods of the year.

Measures and Practices through 1965

Since the 1930's range rehabilitation and protection work have been initiated through soil stabilization and cover improvement measures, watershed oriented land management practices, and development of water control structures. Most rangeland measures and practices have multiple objectives and benefits. Many serve management objectives other than improving the watershed.

Measures and practices completed prior to 1966 are shown on table 19 for both public and private lands. This table indicates the purpose of each reported measure or practice in terms of four major watershed improvement objectives: (1) drainage, (2) water conservation, (3) erosion and water quality control, and (4) flood and debris control.

Table 19 - Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, Columbia-North Pacific Region, 1966

Measures & Practices	Units	Land Ownership Public 2/	Private	Total	Watershed Purposes 1/ (1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	2,050,700	1,069,300	3,120,000	-	x	x	-
Brush Control	Acres	1,205,500	1,561,800	2,767,300	-	x	x	-
Weed Control	Acres	548,100	517,600	1,065,700	-	x	x	-
Fertilizing	Acres	6,700	3,800	10,500	-	x	x	-
Conversion of tree cover to grass	Acres	5,800	15,300	21,100	-	x	x	x
Contouring, Pitting, Furrowing	Acres	9,400	3,500	12,900	-	x	x	-
Deep Tillage	Acres	200	200	400	x	x	-	-
Stream & Bank Stabilization	Acres	1,500	2,500	4,000	-	x	x	x
Waterspreading	Acres	3,000	31,000	34,000	-	x	x	-
Irrigation	Acres	2,000	4,200	6,200	-	x	-	-
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	177,200	49,500	226,700	-	x	x	-
Reducing Excessive Grazing Use	Acres	20,699,100	9,599,100	30,298,200	-	x	x	x
Livestock & Game Water Facilities	Number	8,200	13,000	21,200	-	x	x	-
Road Stabilization	Miles	2,800	NA 3/	NA 3/	x	x	x	x
Stream Clearance	Miles	10	15	25	x	x	x	x
Pollution abatement	Miles	400	300	700	-	-	x	-
Water Control Structures								
Ponds & Small Reservoirs	Number	5,300	4,400	9,700	-	x	x	x
	Acre Ft.	95,000	30,700	125,700	-	x	x	x
Detentions	Number	200	300	500	x	x	x	x
	Cu. Yds.	189,800	191,000	380,800	x	x	x	x
Check Dams (Gully Plugs)	Number	5,800	7,000	12,800	-	x	x	-
	Cu. Yds.	87,900	72,000	159,900	-	x	x	-
Dikes	Lin. Ft.	269,600	114,000	383,600	x	x	x	x
Diversions	Number	200	700	900	x	x	x	x
	Cu. Yds.	183,800	1,050,600	1,234,400	x	x	x	x

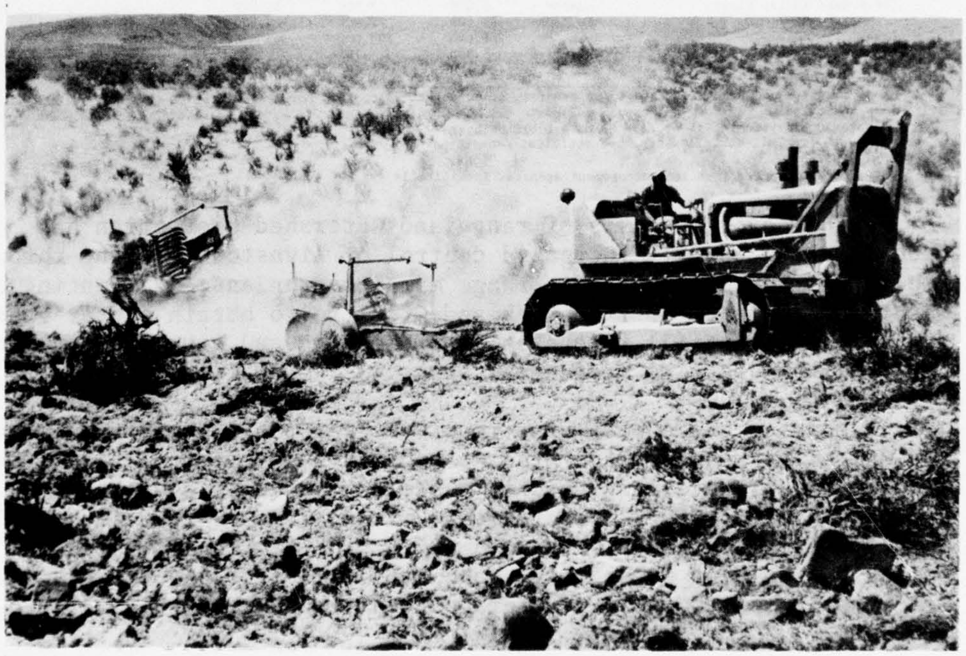
1/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1 - Drainage; Col. 2 - Water Conservation; Col. 3 - Erosion & Water Quality Control; Col. 4 - Flood & Debris Control.
2/ Includes Federal, state, county, and municipal ownership.
3/ Not available.
Source: Data collected from land management agencies specifically for the C-NP Study.

The major emphasis of rangeland watershed protection has been directed to: (1) increased control of livestock grazing through implementation of scientific range management plans; (2) fencing and water development for livestock and wildlife to obtain better grazing distribution; (3) revegetation by seeding and brush control; and (4) expanded fire protection programs.

Many of these past practices were for the primary purpose of increasing range forage production. This has been particularly true on the private range sector where economies of operation prevent the individual operator from making a major investment in specific broad coverage watershed protection or rehabilitation unless his holding is directly benefited. However, in the process of improving productivity, watershed conditions have generally been improved.

Cover Improvement and Soil Stabilization Cover improvement and soil stabilization practices have been applied on about 7.0 million acres of rangeland in the region through 1965. On 3.1 million acres, grasses, legumes, forbs, and browse species have been established to provide more ground cover, to resist erosion, and to improve forage conditions for livestock and wildlife. About 37 percent of the revegetation was accomplished in Subregion 4; 28 percent in Subregion 5; 12 percent in Subregion 12; and lesser but significant amounts in Subregions 2, 6, and 7. An estimated 20 percent of the seeding was for water conservation or increased water yields and 35 percent for erosion and water quality control. Some 45 percent was for improved livestock and wildlife forage production.

Brush was controlled on an estimated 2.8 million acres to reduce woody vegetation and replace it with more useful, protective, and erosion resistant vegetation. More than two-thirds of the brush control was in Subregions 4 and 5, with lesser amounts in Subregions 7 and 12. Some 25 percent of the brush control was for improved water yields or water conservation and 30 percent was for erosion and water quality control; the remainder was for improved forage production.



On this deteriorated range, brush has been controlled and the area is being plowed for seeding to a more useful, protective, and erosion resistant cover. (Bureau of Land Management)

Water has been spread on about 34,000 acres, primarily in Subregion 12, through the use of dikes, diversions, and contour ditches. This provided better distribution of surface water runoff and infiltration. Tree cover (mostly juniper) was converted to grass or shrubs on 21,100 acres, primarily in Subregion 7, improving the vegetative cover for forage production and to stabilize the soil, conserve moisture, and reduce excess runoff. Other measures and practices for cover improvement and soil stabilization included weed control on 1.1 million acres; 12,900 acres contoured, pitted, or furrowed; 10,500 acres fertilized; 6,200 acres irrigated; about 180 miles of streambank stabilization; and deep tillage on 400 acres.

Watershed Oriented Land Management Practices Significant progress has been made in adjusting livestock use to the current grazing capacity of the range and attaining better livestock distribution in many parts of the region. Excessive grazing use has been reduced on an estimated 30.3 million acres or 52 percent of the total rangeland. About 36 percent of this reduction occurred in Subregion 4, 18 percent in Subregion 5, 15 percent in Subregion 6, and 13 percent in Subregion 12. Of major importance in effecting this adjustment has been the development of grazing management systems that provide sufficient rest periods for natural revegetation of range cover.

An estimated 226,700 miles of livestock control fence have been constructed. This includes all fencing used within a watershed or management unit as an integral part of a conservation treatment plan for the protection of conservation works, rehabilitation of eroded or deteriorated lands, or to control livestock use in areas of primary value for fish and wildlife. A substantial percentage of the livestock control fencing was reported in Subregion 4. Two-thirds of the fence construction was for watershed protection purposes and one-third was for other management objectives.

Water for livestock is normally adequate in the spring; however, many sources are depleted during the summer months. Additional water development has been necessary to insure more uniform utilization by game and livestock. About 21,000 livestock and game water facilities such as springs, wells, troughs, and ponds have been developed primarily in Subregions 4, 5, 6, and 7. Some 20 percent of the water facility development was for watershed improvement and protection while 80 percent was for improved livestock distribution and wildlife habitat improvement.

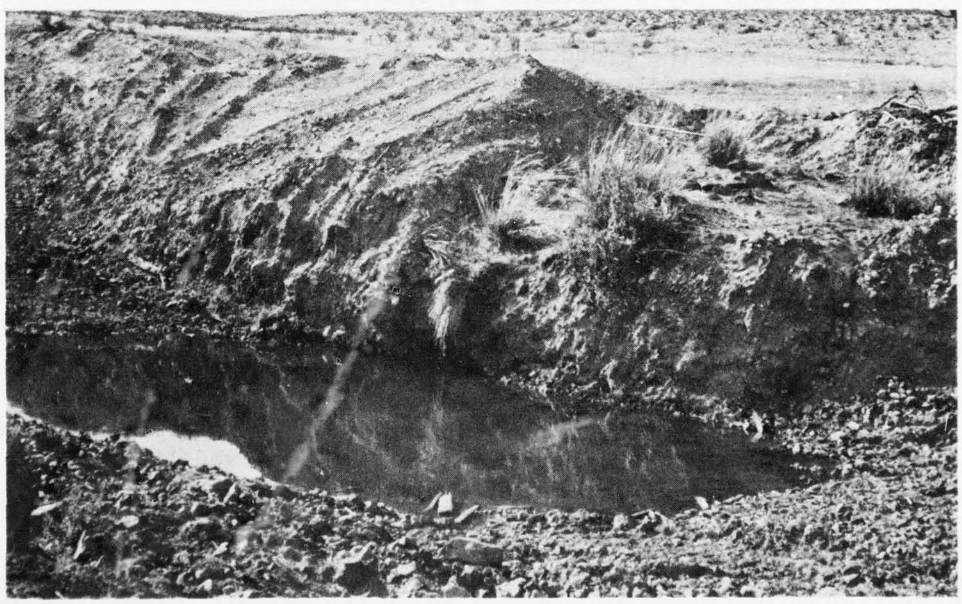
Watershed protection measures have been included in the maintenance and improvement of about 2,800 miles of public access roads and trails and a lesser mileage on the private range. These protection measures included ditches and culverts to control runoff; mulching, fertilizing, and seeding of cut banks and fill slopes;

and protection of culvert outfalls. About half of these efforts were for erosion and water quality control.

Stream clearance was reported along 25 miles of rangeland waterways. About a third of this was for erosion and water quality control with lesser benefits for drainage, water conservation, and flood and debris control.

Pollution abatement practices were accomplished on about 700 miles of rangeland streams. This included such measures as excluding livestock from streambeds and springs, and providing sanitary facilities for public recreation use near streams and lakes. These were accomplished primarily in Subregions 2 and 3.

Water Control Structures Water control structures have been developed to reduce erosion, control debris, and conserve early season runoff for subsequent livestock, recreation, and fish and wildlife use. An estimated 9,700 ponds and small reservoirs have been constructed on rangeland with a total storage capacity of 125,700 acre-feet. More than a third of these structures were developed in Subregion 7, and significant numbers were reported in Subregions 4, 5, and 12.



An estimated 9,700 ponds and small reservoirs have been constructed on rangeland to conserve early season runoff for subsequent livestock and wildlife use. (SCS B-249-3)

Most of the 500 detention structures reported were in Subregions 4 and 7, primarily for water conservation and erosion control. These are structures with a fixed outlet at or near ground level developed to control downstream movement of sediment, stabilize channels, and provide temporary storage of runoff. Check dams are barriers of earth and other material constructed in gullies and other water courses to decrease the velocity of water flow. About 12,800 such dams were developed to 1966, mainly in Subregions 4, 5, and 7.

Throughout the region, 73 miles of dikes have been constructed on rangeland to control, guide, or deflect water flow, or to protect other conservation works. Nearly 40 percent of these were reported in Subregion 4, 31 percent in Subregion 3, 19 percent in Subregion 12, and a smaller percentage in other subregions. Some 900 diversion dams have been built in the region, primarily in Subregions 1, 4, and 7, with lesser numbers in Subregions 2 and 3. These dams raise water out of a defined channel and divert it to a water spreading area or into a reservoir.

Present Range Condition

Some rangeland measures and practices accomplished through 1965 have resulted in notable watershed improvement and improved range forage production. Others have succeeded in halting a deteriorating range condition, although rehabilitation and improvement will be a slow, time-consuming process. Condition of various categories of rangeland in 1966 and the estimated grazing capacity of each in animal unit months are shown on table 20 for both public and private ownership. Range condition classes on this table do not relate strictly to watershed condition, but to the combined characteristics of forage stand, site condition, and soil mantle. (Definitions appear in Appendix IV.) In a broad sense, these condition classes may be favorably related to condition of the watershed.

About 20 percent of all rangeland (including seeded areas), is in good condition, 43 percent in fair condition, and 37 percent in poor condition. Of the total range grazing capacity of 7.3 million animal unit months, good condition range accounts for 43 percent, fair condition 40 percent, and poor condition 17 percent. Overall, private lands are in better condition than public lands. They represent 34 percent of the total range acreage and 41 percent of the total grazing capacity. The estimated average grazing capacity of the private range is 6.7 acres per animal unit month compared to 9.0 acres on public lands. On much of the poor condition range, desirable native forage plants have been practically eliminated either by overgrazing or by range fires.

Table 20 - Rangeland Condition and Capacity,
Columbia-North Pacific Region, 1966

Range Type and Condition	Ownership Public Acres (1,000)	Public AUM's (1,000)	Private Acres (1,000)	Private AUM's (1,000)	Total Acres (1,000)	Total AUM's (1,000)
Grassland						
Good	914.7	275.3	2,153.8	710.5	3,068.5	985.8
Fair	2,287.1	339.7	3,574.3	535.1	5,861.4	874.8
Poor	2,002.4	147.4	3,562.7	272.5	5,565.1	419.9
Seeded Range 1/	2,000.1	660.6	1,047.5	363.5	3,047.6	1,024.1
Total	7,204.3	1,423.0	10,338.3	1,881.6	17,542.6	3,304.6
Sagebrush						
Good	2,621.4	583.7	2,254.0	389.4	4,875.4	973.1
Fair	14,683.9	1,480.4	3,522.3	367.5	18,206.2	1,847.9
Poor	12,145.3	637.2	2,215.8	111.7	14,361.1	748.9
Total	29,450.6	2,701.3	7,992.1	868.6	37,442.7	3,569.9
Other Brush						
Good	245.4	50.4	369.9	92.6	615.3	143.0
Fair	764.8	81.9	681.3	87.4	1,446.1	169.3
Poor	1,154.5	55.8	543.4	26.4	1,697.9	82.2
Total	2,164.7	188.1	1,594.6	206.4	3,759.3	394.5
Total						
Good 2/	5,781.6	1,570.0	5,825.2	1,556.0	11,606.8	3,126.0
Fair	17,735.8	1,902.0	7,777.9	990.0	25,513.7	2,892.0
Poor	15,302.2	840.4	6,321.9	410.6	21,624.1	1,251.0
Grand Total	38,819.6	4,312.4	19,925.0	2,956.6	58,744.6	7,269.0
Percent Distribution	66.1	59.3	33.9	40.7	100.0	100.0
Average AC/AUM	9.0		6.7		8.1	

1/ Seeded range acreage was combined with good and fair condition grassland in Appendix IV.
2/ Includes seeded range.
Source: Rangeland narrative, C-NP Appendix IV, Region. Range production has been estimated for the C-NP Study from representative situations observed and recorded in on-site surveys. Estimates are based on perennial vegetation and proper utilization.

The average annual sediment yield from rangeland in the region is 11,153 acre-feet (table 21). This has been estimated from measurements at stream gage stations which record average and maximum sediment load concentrations. The five sediment yield categories on table 21 have been arbitrarily named and refer to generalized range areas on which the annual sediment yield per square mile averages .06, .15, .35, 1.00, and 2.75 acre-feet respectively. Many lesser size tracts within these generalized areas may have either higher or lower sediment yields than those indicated.

Almost two-thirds of all rangeland falls in the "Very Low" sediment yield category with an average annual sediment yield of .06 acre-feet per square mile. These range areas account for about 31 percent of the annual sediment yield. The other 69 percent comes from about a third of the rangeland or some 21.4 million acres; these areas require more attention to erosion and sedimentation problems. More serious yields come from about 3.4 million

Table 21 - Sediment Yield from Rangeland
Columbia-North Pacific Region, 1966

Sediment Yield 1/ Categories	Grassland	Sagebrush & Shrubs	Total	Percent
		Rangeland Acreage (1,000 Acres)		
Very Low	11,367.7	26,025.9	37,393.6	64
Low	3,562.0	14,403.3	17,965.3	31
Medium	1,800.1	607.6	2,407.7	4
High	625.9	135.7	761.6	1
Very High	186.9	29.5	216.4	-
Total	17,542.6	41,202.0	58,744.6	100
		Annual Sediment Yield (Acre-Feet)		
Very Low	1,066	2,440	3,506	31
Low	834	3,376	4,210	38
Medium	985	332	1,317	12
High	978	212	1,190	11
Very High	803	127	930	8
Total	4,666	6,487	11,153	100

1/ Very Low through Very High categories represent generalized range areas on which annual sediment yield per square mile averages .06, .15, .35, 1.00, and 2.75 acre-feet respectively.
Source: Derived from figure 1 and the generalized sediment yield maps in subregional sections of this appendix.

acres of rangeland (6 percent of all rangeland) which accounts for about 3,400 acre-feet annually (31 percent of all sediment yield). These lands are located mostly in the western part of Subregion 6, in the northeastern part of Subregion 7, and in scattered areas of the northwestern part of Subregion 5.

In summary, a number of rangeland areas are now in good watershed condition as the result of land treatment measures and practices, as well as improved range management techniques. Other deteriorated range areas are receiving proper attention, and, under continued good management, will eventually become fully restored. Yet, there are still many parts of the range where present uses are not compatible with favorable long-term watershed conditions.

Erosion of unprotected rangeland results in deposits of sediment in streams and downstream areas, decreasing the quality of water, harming fish life, and damaging cropland, urban areas, and roads. (Bureau of Land Management)

Other Land

Other Land is comprised of urban and industrial areas, roads and railroads, farmsteads, small bodies of water, and barren land. These areas total about 8.3 million acres or almost 6 percent of the region. Table 22 shows the acreage of other land by subregion.

Table 22 - Other Land Areas, The C-NP Region, 1966

Subregion	Domestic 1/	Roads 2/	Water	Barren	Total
	---------------------	-----1000	acres-----	---------------------	
1	212.1	143.2	60.6	911.2	1,327.1
2	108.1	127.6	30.8	269.5	536.0
3	52.0	27.8	12.9	28.7	121.4
4	106.9	81.5	28.0	831.4	1,047.8
5	73.0	79.0	37.5	549.9	739.4
6	48.9	69.1	28.6	567.9	714.5
7	80.9	101.9	36.4	346.0	565.2
8	50.5	29.6	26.2	152.3	258.6
9	555.1	60.0	72.4	128.4	815.9
10	124.3	64.0	67.3	216.6	472.2
11	567.3	72.9	40.5	640.9	1,321.6
12	8.1	12.9	8.7	374.0	403.7
Total	1,987.2	869.5	449.9	5,016.8	8,323.4

1/ Includes urban, industrial, airports, golf courses, farmsteads, and other.
2/ Railroads and county, state, and Federal roads.
Source: C-NP Appendix IV, Land and Minerals Resources

Urban areas have had an average annual growth rate of nearly 3 percent over the past 40 years. Roads have increased with settlement expansion. Water areas have become larger with reservoir construction.

Barren areas, including dunes, rock, and alkali flats have remained fairly constant. Dunes have been stabilized and alkali spots have been reduced but some vegetated areas are lost through dune encroachment, slides, floods, or other phenomena.

Factors that cause increases in acreages of other lands may also have good and adverse effects on land use. On the positive side, new reservoirs provide irrigation, recreation, fishing, fire protection, domestic water, and flood protection. Population growth

increases the demand for food and fiber, thereby increasing the market for crops, livestock and timber products. New and better roads give ready access to markets and expand marketing areas.

However, expansion of urban areas and industrial facilities create problems in rural areas. Some of these are: (1) inflation of cropland values with taxes increasing to the point where the cost of production and the necessary cost for land and watershed management cannot be met from the agricultural base; (2) land speculation that prematurely removes land from crop production; and (3) urban and industrial developments,with roofs, paved streets, and parking lots, increase runoff to almost 100 percent of the precipitation.

Urban areas have grown more or less haphazardly without considering long-term social, economic, or esthetic effects. Houses and housing developments have been built with little thought being given to such things as soil, flood, and drainage limitations. Industrial sites have been developed near transportation, water, or power without due consideration given to such items as pollution of water or air.

The coastal areas of Oregon and Washington have encroaching dunes, beach erosion, and silting problems in shipping channels and drainage outlets. These are discussed in more detail in Subregion 10 of this report and in Appendix X, Navigation.

FUTURE NEEDS

The population in the region is expected to increase almost 134 percent by 2020. This trend will place a greater demand on the land and water resources for food, fiber, transportation, recreation, and related interests. Table 23 shows the projected trends in population by target dates.

Other land areas now comprise nearly 6 percent of the region and nonagricultural needs for land are accelerating at a faster rate than are agricultural forestry and grazing needs. Projections based on population trends indicate that future demands will require most intensive multiple use of lands and resources. Such multiple use will require planning beyond that currently practiced by most landowners. A significant increase in other land use is anticipated in the future. This growth can be expected to encroach on the present agricultural land base. Future demands will require a shift in the use of soil and water resources, resulting in a changing pattern of conservation needs. Land use projections based on population growth, expected yields, and other information are shown in table 24.

Table 23 - Total Farm and Nonfarm Population, 1960 with Projections for 1980, 2000, and 2020, Columbia-North Pacific Region and Subregions

Sub-regions	Population Characteristic	1960	1980	2000	2020
1	Total	563.7	699.1	897.1	1,140.4
	Farm	(36.3)	(23.3)	(19.7)	(15.5)
2	Total	193.5	253.0	334.0	431.3
	Farm	(35.7)	(24.5)	(20.6)	(16.2)
3	Total	227.6	280.7	355.2	443.7
	Farm	(32.6)	(23.2)	(19.0)	(15.4)
4	Total	277.2	350.9	450.5	576.0
	Farm	(69.4)	(51.2)	(43.0)	(35.2)
5	Total	252.5	328.7	430.4	553.5
	Farm	(47.9)	(30.1)	(25.5)	(20.0)
6	Total	155.9	193.9	234.6	274.3
	Farm	(26.6)	(18.4)	(15.0)	(11.7)
7	Total	198.7	251.4	321.9	404.4
	Farm	(28.5)	(19.1)	(15.5)	(12.0)
8	Total	224.5	277.9	349.4	441.3
	Farm	(20.1)	(13.3)	(10.1)	(7.1)
9	Total	1,168.9	1,727.3	2,397.6	3,237.1
	Farm	(69.0)	(43.4)	(32.8)	(25.6)
10	Total	381.4	465.4	575.4	708.9
	Farm	(27.2)	(17.6)	(14.7)	(10.9)
11	Total	1,768.1	2,449.7	3,345.3	4,448.1
	Farm	(47.9)	(23.8)	(17.8)	(13.7)
12	Total	13.9	16.3	18.7	21.3
	Farm	(2.1)	(1.9)	(1.7)	(1.6)
	Total	5,425.9	7,294.3	9,710.1	12,680.3
	Farm	(443.3)	(289.8)	(235.4)	(184.9)

Source: Appendix VI, Economic Base Studies and Projections

Table 24 - Projected Change in Cover and Land Use, The Columbia-North Pacific Region

Cover & Land Use	1966	1980	2000	2020
		(1,000 acres)		
Cropland	20,804	21,552	21,407	21,642
Forest Land	85,844	85,416	84,795	84,160
Rangeland	58,745	57,309	57,089	56,461
Other Land	8,323	8,954	9,708	10,488
Total Land1/	173,716	173,231	172,999	172,751

1/ Totals reflect an increase in water surface areas.
Source: Economic Work Group Projections

Cropland

The increased need for agricultural products will require: (1) Yield increases through new and improved technology and use of fertilizer; (2) increase in cropland areas; and (3) an increase in the area of irrigated cropland. The projected dry and irrigated cropland acreage required to supply the food and fiber needs will increase about 4 percent by 2020 (less than a million acres) (table 25). In general, east of the Cascade Range cropland acreages will increase while west of the Cascade Range they will decrease because of urban and industrial expansion. Projected changes in the subregions are consistent with the past trends. Appendix VI, Economic Base and Projections, explains the methodology used in developing the land use projections.

Table 25 - Projected Trends in Dry and Irrigated Cropland, The Columbia-North Pacific Region

Type of Cropland	1966	1980	2000	2020
		(1,000 acres)		
Dry Cropland	13,672	11,733	10,347	8,537
Irrigated Cropland1/	7,132	9,819	11,060	13,105
Total2/	20,804	21,552	21,407	21,642

1/ Approximately 97 percent of total irrigated area, Appendix IX, Irrigation
2/ Economic Work Group Projections

Sweeping changes have been occurring in the agricultural field in the past 20 years. Even more changes can be expected to affect future crop production. This can be attributed to a number of factors, of which improved technology, the price squeeze, and the high price and scarcity of farm labor are probably the most important. Changes in buying habits of people are also expected to cause some shifts in cropping patterns during the next 50 years.

Water Conservation

The Columbia-North Pacific Region is expected to experience a large expansion of its irrigated cropland by the year 2020. There are a number of reasons for this prediction: (1) There is ample water in most parts of the region to provide water for both agricultural and other uses; (2) there are ample additional irrigable soils in close proximity to a water supply; (3) the growing season over much of the region is suitable for a variety of field, vegetable, fruit, and nut crops; (4) increasing population in the region will increase the demand for food and fiber; (5) transportation by air, water, rail, and highway is available to insure access to national and world markets. The region has over 9 million acres of land that could qualify under item (2). Projections indicate that approximately 65 percent of this acreage will be under irrigation by the year 2020. This will increase the irrigated cropland area to over 13 million acres.

Drainage

The area of cropland with drainage problems is expected to increase about 16 percent with the increase in irrigated acreage. The predominant reasons are:

1. As urban growth removes agricultural land from production, cropland will expand onto less suitable land.

2. Irrigation is projected to increase by almost 6 million acres. This increased application of water will increase the drainage problem.

The projected trend in the drainage problem is shown in table 26 by subregion.

Table 26 - Projected Cropland Areas with Wetness Problems, The Columbia-North Pacific Region

Subregion	1966	1980	2000	2020
	----------------1000 Acres----------			
1	168.0	182.0	215.0	249.0
2	107.0	115.0	126.2	137.4
3	113.1	121.0	138.0	155.0
4	396.3	427.1	439.6	458.0
5	181.8	204.0	230.6	273.0
6	151.0	152.4	154.2	156.4
7	57.8	63.4	74.6	85.8
8	88.0	89.0	91.0	92.0
9	420.0	439.0	464.0	490.0
10	192.0	226.3	234.0	241.6
11	518.0	490.0	448.0	367.0
12	133.8	137.4	142.2	147.1
Total	2,526.8	2,646.6	2,757.4	2,852.3

Source: Soil Conservation Service C-NPRBS Data

Erosion and Sedimentation

Cropland areas with a potential erosion problem are expected to increase about 12 percent by 2020. As agricultural land is converted to other uses, cropping will expand onto other less desirable land which is expected to be more erodible than present cropland. Table 27 shows the projected trend.

Table 27 - Projected Cropland Areas with an Erosion Potential The Columbia-North Pacific Region

Subregion	1966	1980	2000	2020
	----------------1000 Acres----------			
1	1,292	1,386	1,481	1,575
2	2,523	2,408	2,319	2,260
3	497	470	435	400
4	2,203	2,473	2,654	2,894
5	863	1,007	1,199	1,392
6	2,661	2,734	2,831	2,928
7	2,031	2,086	2,159	2,234
8	62	57	50	43
9	720	740	770	800
10	597	600	603	606
11	294	289	283	277
12	82	86	92	97
Total	13,825	14,336	14,876	15,506

Source: Soil Conservation Service, C-NPRBS Data

Flooding

A major part of the over 1.6 million acres of cropland subject to flooding is used for hay and pasture, protecting it from the flood waters. There are many thousands of acres that are potentially excellent cropland still used for forest or range because of the flood hazard. It is expected the needs for more cropland will force some of this land into more intensive use to about offset the loss of cropland with a flood hazard to other uses. This land requires more specific and expensive practices when used intensively, but the total acres needing treatment will remain fairly constant. Channel improvement and other flood control measures should reduce the hazard substantially. A more complete discussion of flood reduction can be found in Appendix VII, Flood Control.

Forest Land

The forest and wood-using industries will require nearly 5.3 billion cubic feet of raw material per year by the year 2020. To meet this requirement, this raw material, disregarding imports, will be produced on the 68.6 million acres estimated to remain in commercial forest land production by the end of this same time period. This can be expressed as a need or demand for 77 cubic feet per acre. The present regional consumptive rate is 4.3 billion cubic feet per year, or 62 cubic feet per acre. Net annual growth ranges from 15 cubic feet per acre in western Montana to slightly over 100 cubic feet in western Washington, the regional average being close to 40 cubic feet per acre. It is apparent that these rates will be inadequate to meet present and future industrial demand (figure 3).

It is projected that the commercial forest land base in the region will diminish. Urban expansion, highways, powerlines, reservoirs, and single purpose reservations will be the principal competitive uses. It is also projected that the demands for wood products, lumber, plywood, pulp and paper will increase; pulp and paper by threefold. Unless intensive timber cultural practices are adopted and their use accelerated, the projected demand for wood fiber will result in unacceptable watershed conditions as well as wood fiber shortages. It is, therefore, apparent that intensive forest management practices will be required if growth is to approximate future industrial requirements and stable production is to be maintained. Concentration of wood fiber production on the most stable landscapes and areas of highest productivity will serve to reduce undesirable impacts on forest land which are less stable and are less easily managed for watershed protection purposes. These practices will take many forms and may vary, subregion by subregion. Increased access road construction, quicker salvage of

mortality, more complete utilization of present supplies, increased and faster restocking, tree fertilization, thinnings, release and selective tree breeding are some of the major tools presently being considered.

Some of these silvicultural practices have a side benefit of improving watershed conditions. Thinnings, designed principally to improve tree growth by reduction in competition, are applied to dense, stagnated stands. This practice opens the tree canopy, permits browse to develop on the forest floor, and, as such, improves the forest area for range and wildlife use. It also reduces evapotranspiration with this reduction in competition. In the pine forests grazing is one of the major parts of the economy. These forest areas, generally in a higher precipitation zone, may have better soil types, with less saline content than the sagebrush-juniper type at lower elevations. Accordingly, they produce better browse. Allowing for seasonal limitations, the forest range can support more use than it now does, particularly on the private sector. This thinning program therefore produces multiple benefits by improving both timber, forage, and water yields.

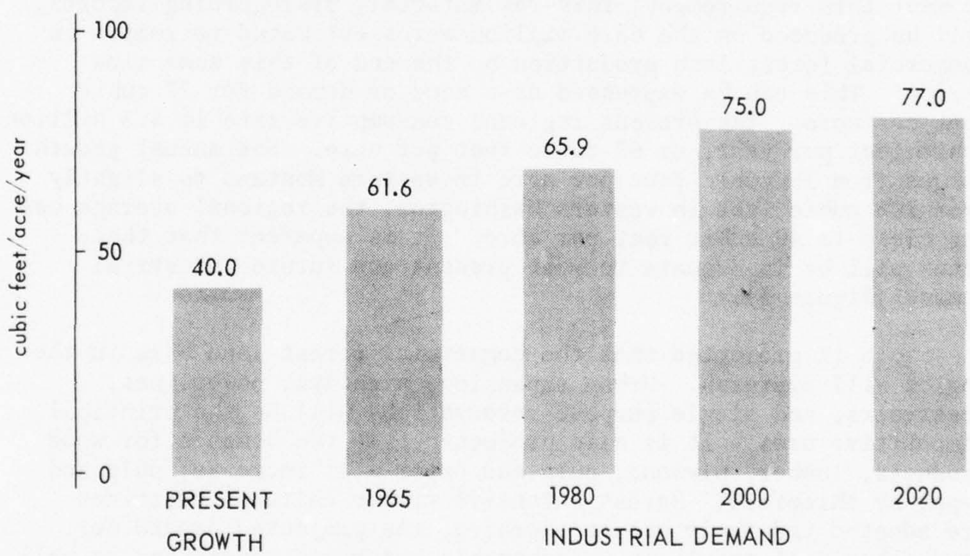


FIGURE 3. Growth rates and present and future industrial consumptive demand for wood fiber in the Columbia-North Pacific Region.1/

1/ Forest industrial consumptive requirements from Appendix VI, Economic Base Studies and Projections.

Artificial reforestation restores a protective cover to a denuded timber harvest area. Although many logged-off areas do reseed to brush, itself a protective cover, artificial reforestation may, in some cases, be the only way a protective cover can be restored. This tends to reduce overland flows and resultant sedimentation.

Large areas within the region are presently nonstocked. These are the result of logging and forest fire, and presently amount to nearly 2.5 million acres. Some occupy sites of high productivity. Those not in critical big game winter range areas must be returned to timber production. Timberland owners are presently engaged in a major reforestation effort to restock these areas. Some areas are planted, others seeded by aircraft. Some require extensive site preparation prior to planting. One regeneration method calls for the construction of contour furrows. The trees are planted in these furrows, mainly to take advantage of the soil

A reforestation effort in an old burn in northern Idaho. Contour furrows constructed to collect soil moisture for tree survival, also reduce overland flows. (Forest Service)

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moisture collected there. The furrows also reduce competition with brush and grass and have the additional benefit of reducing downslope water movement by permitting moisture to filter into the soil.

Forage production under the forest canopy is highly dependent upon the density and composition of the forest stand. Generally, lower tree densities are associated with higher understory production. Although forage production demand levels for livestock use have not been made, grazing capacity of forest land in the future will be principally dependent upon the level and type of silvicultural management which is applied.

Present forest successional trends on much of the forage producing forest land are toward denser forest types which will reduce forage production. Also at the present time, silvicultural management is directed toward the development and maintenance of forest stands which will severely restrain the favorable continuation of forage at present levels.

Successional trends and present silvicultural management are expected to perpetuate the downward trend in forage production and grazing use on forest lands. Grazing use is not expected to completely pass from the forest scene, but the decline will continue unless a major change in silviculture management is adopted on both public and private forest range.

In conclusion, it should be pointed out that there are a number of cultural practices planned by both the public and private forest landowners to increase forest yields. Many also assist in maintaining or improving forest watershed conditions. But at the same time, more competition between forest land uses means more pressure on the forest resource. This can be extremely critical as these forests occupy some of the more highly erodible soils. As such, they represent a major sediment source if improperly managed.

Watershed Protection

Erosion and sediment yield potential for the forest lands is based on a timber harvest program using logging methods that successfully remove the timber but make no provision for watershed protection requirements. This results in a heavy vegetation disturbance and a high percentage of ground disturbance. This disturbance, coupled with the normal climatic conditions of the area, rainfall and runoff, could produce critical amounts of soil loss and ensuing stream sedimentation. Table 28 summarizes this information, and maps of these areas are included in the subregion sections.

Table 28 - Potential Sediment Yield Without Protective Measures, Forest Land, Columbia-North Pacific Region

Soil Loss Category	Acres (1,000)	Percent	Acre-feet per Square Miles Per Year	Total Acre-feet Per Year
Low	49,562.1	58	Less than 0.2	8,424
Medium	26,078.6	30	0.2 - 1.5	13,180
High	10,202.8	12	More than 1.5	23,915
Total	85,843.5	100		45,519

Source: Soil Survey Data & Interpretations, Forest Service, Regions 1, 4, and 6.

Around 12 percent of the forest land is in the "high" potential category where total sediment yields could approach 25,000 acre-feet per year. This alone is more than two and one-half times present sediment yield from all forest land. With such a high potential, watershed protection standards need to be maintained, improved, and enforced in all areas.

Timber consumption will increase 23 percent through the year 2020. This will result in an acceleration of the present timber harvest. Road construction will also accelerate above present construction rates, at least until the ultimate road system is complete. This acceleration will be necessary to utilize as much dead and dying timber as possible, particularly if projected industrial demands are to be met. Full harvest of mortality, from fire, insect, and disease, is one of the many tools necessary to meet these goals. The projected timber harvest and road construction program are listed on table 29. Also included is the acreage of ground disturbed during these operations. This is the area that will require watershed protection practices such as seeding, mulching, and other land treatment measures.

If full wood fiber needs cannot be met by the above mentioned practices, reduction in rotation ages may be necessary. If this is the case, the data in table 29 may be shifted and greater road construction, harvest acreages, and ground disturbances would be experienced in the earlier time periods. This table and comparable tables in the subregional section are based on existing rotation ages.

Data in table 29 indicate that more than 42 million acres, over half the commercial forest land, will come under harvest by the year 2020. Over 5-1/2 million acres, almost 10 percent, will have its present ground cover severely disturbed by logging and road construction. This is the area from which much of the

Table 29 - Projected Cumulative Timber Harvest Activity
Forest Land, Columbia-North Pacific Region1/

Item	Unit	1980	2000	2020
Timber Harvest	Ac.	12,669,000	27,868,000	42,443,000
Road Construction	Mi.	73,500	159,500	241,500
Ground Disturbance2/	Ac.	1,697,000	3,752,000	5,731,000

1/ Based on the 1965 level of timber requirements.
2/ Includes both harvest area requiring protection and road mileage, converted to acres, requiring cut and fill treatment.

high levels of sediment could be expected. Since this is a cumulative figure, this acreage will not be disturbed all at one time. Natural reseeding and watershed treatment measures will be used to mitigate this disturbance as it occurs. This figure is presented to emphasize the impact of timber harvesting practices on the forest cover. The annual disturbance is depicted on table 16.

Watershed Rehabilitation

Future demands for water will require improved water quality through reduced sediment loads, especially for domestic, industrial, agricultural, and recreational purposes.

Watershed rehabilitation work is still required on much of the forest land in the medium through very high sediment yield categories (tables 14 and 15). Present inventories show a need for erosion treatment on almost 1.8 million acres of forest land, 84,000 miles of eroding or damaged streambank and channel, and 32,000 miles of forest utilization road. Past protective measures were limited and additional rehabilitation work is still necessary.

Water Yield Improvement

Water quantities and the timing of runoff may be as important as the quality of the water produced on forest lands. Presently 205 million acre-feet of runoff originate on the forest areas. Management of this forest cover can produce additional runoff by reducing evapotranspiration, inducing snow accumulation and reducing snowmelt.

The available water retention capacity of the forest soils is expressed in acre-feet per square mile and shown in table 30.

It differs from the total storage capacity expressed in Appendix IV, Land & Mineral Resources, as it considers not only the top 60 inches of the profile, but the entire depth to the impervious layer. In some subregions with extremely shallow soils, the depth may extend down into the fractured bedrock. This may be extremely important to water yield improvement programs as they are logically applied only on soils with significant storage capacity.

Table 30 - Water Retention Capacity Forest Soils, Columbia-North Pacific Region

Retention Class	Acres (1,000)	Percent	Acre-feet per Square Mile	Total Acre-feet
Low	24,445.2	28	Less than 300	10,412,000
Medium	57,123.2	67	300 - 1,500	78,270,000
High	4,275.1	5	More than 1,500	29,442,000
Total	85,843.5	100		118,124,000

Source: Soil Survey Data & Interpretations, U.S.D.A. Forest Service, Regions 1, 4, and 6.

Nearly three-quarters of the forest land is in the medium to high available water storage retention area. This area has a potential for storing over 100 million acre-feet, nearly half the total runoff from the region. Water yield improvement programs will aid in diverting more of this runoff into the ground-water storage reservoir, where it may show up as sustained or improved subsequent low flows. Maps of these areas can be found in the subregion sections.

Rangeland

The current rangeland watershed condition indicates the present need for conservation practices to continue maintaining those areas now in satisfactory condition and to improve or rehabilitate those areas damaged by present use. Erosion and sedimentation is presently a significant problem on 8.9 million acres of regional rangeland; flooding problems exist on 309,000 acres; some 439,000 acres have drainage problems.1/ The average annual rangeland sediment yield is about 11,153 acre-feet as shown on table 21. About two-thirds of the yield comes from about 36 percent of the rangeland; and half of this sediment is produced from 3.4 million acres or only 5 percent of the total range acreage. Projected future changes in land and resource use indicate additional requirements to resolve present watershed problems and to provide adequate future protection.

1/ SCS River Basin Survey Data

Projected Use of Range Resources

Livestock ranching is an important economic activity in the region and livestock grazing is a significant use of the land. Rangeland currently provides forage that produces an estimated 9.3 percent of the total beef and sheep production of the region. Projected demand for beef and sheep production gives an indication of additional need for range forage. In 1964, beef and veal production amounted to 1,427.7 million pounds. This is expected to increase to 3,617.5 million pounds or 153 percent by 2020. Sheep and lamb production of 132.4 million pounds in 1964 is projected to 268.9 million pounds, a rise of 103 percent by 2020. (3) Subregions 4 and 5 each account for about 20 percent of this anticipated expansion, and Subregions 1, 2, 3, 6, and 7 for between 7 and 11 percent each. In terms of increased subregional demand over current production, Subregions 2, 3, 4, and 5 rank highest with increases ranging from 175 to 210 percent each. To meet a part of additional livestock production needs, future range forage production must be increased to the extent possible commensurate with proper land management and resource utilization. A reasonable balance must be achieved between domestic livestock use of range forage and use by big game animals.

The regional population is expected to increase 127 percent from 5.6 million in 1962, to 12.7 million in 2020, with an accompanying demand for more urban, industrial, agricultural and recreational land. Cropland acreage will increase about 838,000 acres; urban and "Other" land, 2.2 million acres; and reservoir areas, 965,000 acres. Considerable rangeland will be diverted to these uses. The 58.7 million acre range area of 1966 is expected to decrease to 56.5 million acres or 4 percent by 2020 (table 24). Of this 2.3 million acre loss, 41 percent is anticipated in Subregion 5, 20 percent in Subregion 1, 12 percent in Subregion 2, 11 percent in Subregion 7, and 9 percent in Subregion 4. Lesser decreases in most other subregions account for the remaining 7 percent. Only in Subregion 12 is there a small projected increase.

Watershed Needs

Present watershed measures and practices must be continued to maintain presently favorable watershed conditions and new efforts will be required to rehabilitate deteriorated range areas. This must be accomplished concurrently with an anticipated increased demand for range forage production and a decline in total rangeland acreage. Watershed needs, over and above the present level of development, are discussed by major nonstructural and structural requirements: control and reduction of erosion and sedimentation; protection and management of range resources; stream and channel improvement; bank stabilization; and required dikes and levees.

Erosion and Sedimentation Through 1965, about 4.7 million acres of rangeland had received land treatment for erosion and sedimentation control with accompanying benefits for flood control and drainage. Most measures and practices for cover improvement and soil stabilization given in the "Present Status" section are included in this estimate along with accomplishments in road stabilization. Where multiple practices were involved, overlapping acreage has been deleted. An additional 6.5 million acres will require similar treatment by 1980, 13.8 million acres by 2000, and 20.4 million acres by 2020.

Land treatment for cover improvement and soil stabilization includes erosion control measures, removal of brush species which occupy the site but furnish little soil protection, and revegetation with soil-protecting, drought-resistant grasses. This will reduce erosion and sediment damage, and improve water quality. In order to relieve grazing pressure on badly depleted ranges, special efforts are needed to increase forage production on the higher quality rangeland. A number of small water control structures, such as detention dams, check dams (gully plugs), and diversion dams will be required in conjunction with land treatment to assure adequate erosion and sediment control.

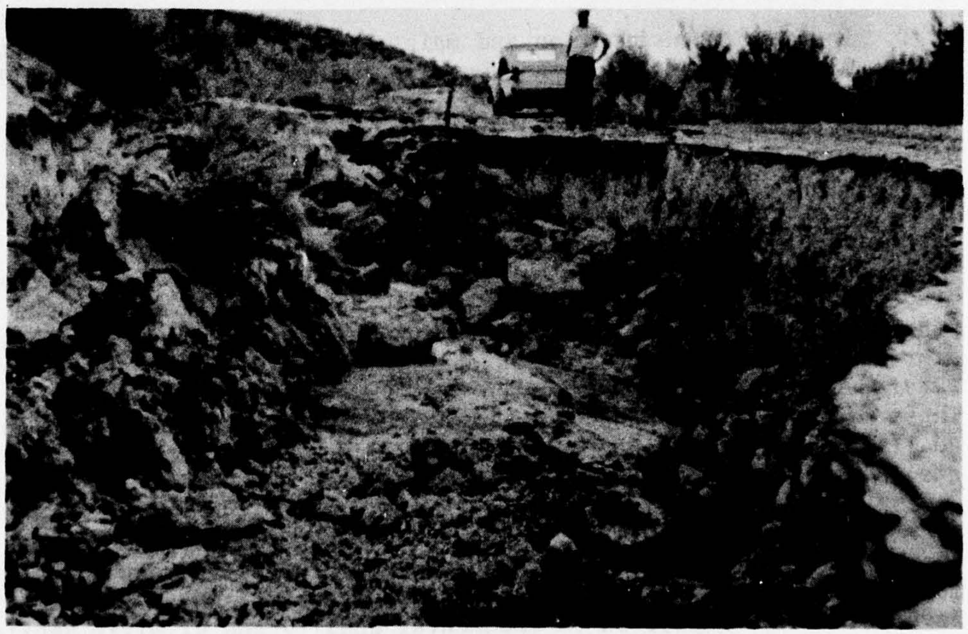
In future construction and maintenance of range access roads and trails, more attention must be given to gradients, soil stability, and disposal of waste material, and to providing adequate measures to reduce erosion and excessive runoff.

Protection and Management On some 30.4 million acres of rangeland, livestock grazing use has been reduced or adjusted to the current grazing capacity of the range, and special fire control practices have been initiated where required. The protection and management category includes other measures for improved livestock distribution and control such as development of livestock and game water facilities and construction of livestock control fences. These protection and management practices should be extended to an additional 14.6 million acres by 1980, 17.0 million acres by 2000, and 18.6 million acres by 2020.

Whenever possible and practicable, watershed improvement should be accomplished by improved and more intensive range management in preference to major construction measures, which frequently have an adverse impact on environmental quality and wildlife habitat. More comprehensive range management practices are needed on both private and public lands for improved livestock grazing use. Rangeland areas of steep slopes, naturally sparse vegetation along stream banks, or on unstable soils, should be left in a relatively undisturbed condition. Grazing should not be allowed to deplete the vegetative cover to a point where protection of the watershed and maintenance of desirable vegetation is impaired.

More information is needed on the relative importance of big game and domestic livestock and their competing use of range forage. Special areas should be identified and developed primarily as a source of winter feed for big game. Wildlife should be held to population levels that the range is capable of supporting. Increased emphasis on fish and wildlife habitat, as well as recreational use of rangeland points out further requirements for more comprehensive range management to meet competitive range resource demands while adequately protecting the watershed.

Uncontrolled range fires destroy range vegetative cover leaving unprotected areas susceptible to wind and water erosion. Some fire protection agencies need additional financial resources to permit control of fires while they are still small. Burned areas of erodible soils should be treated promptly to reestablish protective cover. In other burn areas with stable soils, natural revegetation will occur with proper range management. In some areas, special fire prevention efforts are necessary to help preserve plant litter and to reduce siltation and contamination of water caused by range fires.



Serious erosion and channel cutting has resulted from inadequate construction and drainage of this range road. (Bureau of Land Management)

Channel Improvement An estimated 196 miles of streams and waterways in rangeland areas have been improved by stream clearance, channel work, and pollution abatement efforts. An additional 651 miles need attention by 1980, 1,664 miles by 2000, and 2,337 miles by 2020.

Debris and log jams in a number of water courses must be cleared to allow natural streamflow, prevent streambank cutting and flood damage, and provide free passage of migratory fish to spawning grounds. Many streams require pollution abatement practices to improve water quality for fish habitat and consumptive uses as well as for recreational and esthetic values.

More consideration must be given to water quality standards and control in the use and management of rangelands. Among other requirements, water quality standards must spell out sedimentation levels. Livestock may contribute to bacterial contamination of water supply sources such as springs, seeps, wells, and ponds. Certain stream areas should be protected from direct livestock use and trampling. Poor water quality areas must be identified and specific measures and practices determined that will achieve the objectives of improved water quality along with other range management objectives.

Bank Stabilization In conjunction with land treatment requirements for erosion and sediment control, some 180 miles of bank stabilization work have been accomplished along streams and reservoirs in range areas. This includes the stream and bank stabilization acreages reported in the "Present Status" section converted to miles on the basis of 10 to 40 acres per mile, depending on differing characteristics of the various subregions. Future needs include an additional 1,400 miles of bank stabilization by 1980, 4,700 miles by 2000, and 6,700 miles by 2020.

Levees and Floodwalls About 73 miles of dikes have been constructed on rangelands to help control floods and prevent damage from sediment and debris. An additional 50 miles will be needed by 1980, 127 miles by 2000, and 188 miles by 2020.

Other Land

The other land area of the region is expected to increase about 25 percent from 8.3 million acres in 1966, to 10.4 million acres by 2020 (tables 23 and 24). Most of this expansion will occur in two major categories of land use: (1) urban and industrial areas, and (2) roads, highway, and other special rights-of-way.

The increase of over 130 percent in the region population will create a need for an additional 700,000 acres of urban, industrial, and associated use lands. This will occur principally in Subregion 9, which accounts for 30 percent of the projected growth, and Subregion 11, which will have some 37 percent of the regional increase.

Much of this shift is expected to occur on land adjacent to existing urban centers, often developing along highways leading to city centers. There are a number of problems connected with uncontrolled growth of urban and suburban areas. Homes and industrial sites are being developed on flood plains, buildings are erected in areas with unsuitable foundation conditions, homes are constructed in areas where soils are not suitable for septic tank drains, and housing and industrial developments are made on soils that should remain in agricultural production.

This urban expansion can result in unnecessary soil disturbance. Construction operations scalp off the ground cover, exposing bare soil to the wind and rain. Subsequent high intensity storms can carry these sediments into storm sewers, ditches, culverts, and other improvements, causing costly maintenance work. Temporary protection measures are necessary on the projected 700,000 acres of urban area until they are formally seeded to lawn, landscaped, and mulched or paved.

Paving itself can create additional problems by reducing infiltration to near zero and directing runoff into concentrated areas. Good long-range planning and zoning are needs that can be utilized to alleviate this problem.

Of equal concern is the 1.5 million acres of other land that is projected to be occupied by roads, transmission lines, and other rights-of-way. Much of this area sustains major disturbance from clearing and construction operations, allowing for sedimentation of adjacent water areas. As with the urban areas, immediate short range rehabilitation work is needed. This work should be applied concurrently with construction. Many of the tracts were once highly productive cropland and forest areas, and their productivity loss is serious. However, their response to protective land treatment measures is usually rapid and they should not be left in an unprotected state while sheet and gully erosion is taking place.

The area of small water bodies included in the other land category is expected to increase as the result of demands for additional water storage facilities. Table 31 summarizes the number of watersheds needing water facility development for specified non-agricultural uses and shows where water expansion may occur.

There are several locations along the coastal area where

sand dune stabilization is needed. In addition, there are numerous inland areas, especially in Subregions 2, 3, 4, 5, 7, and 12, that will need stabilization in the future.

Table 31 - Watersheds Needing Nonagricultural Water Development, The Region, 1966

Subregion	Number of Watersheds Needing Water For: Rural Domestic	Livestock	Municipal Industrial	Recreational	Fish Wildlife	Water Quality
1	31	25	34	143	153	87
2	37	20	11	80	85	42
3	18	1	15	19	19	16
4	12	14	22	109	128	82
5	9	13	18	87	105	53
6	16	15	28	84	90	54
7	37	30	48	97	117	82
8	38	18	28	45	45	44
9	86	88	64	118	124	110
10	73	33	101	180	182	163
11	82	23	68	107	107	109
12	-	1	2	34	51	14
Total	439	281	439	1,103	1,206	856

Source: Soil Conservation Service Data

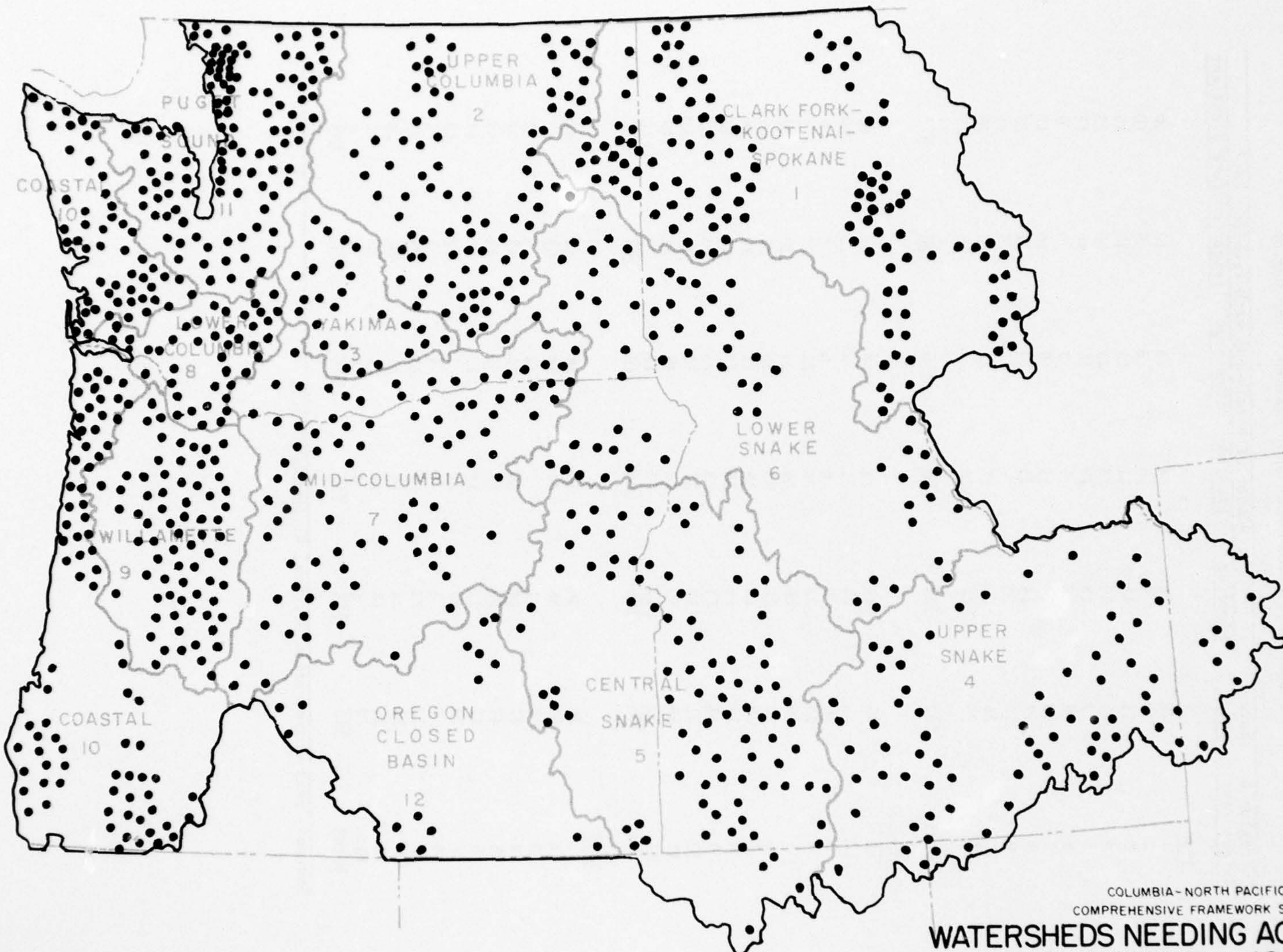
MEANS TO SATISFY NEEDS

The land measures and watershed protection activities needed to assure continued optimum use of the resources are translated in this section into definite structural and nonstructural programs designed to improve and protect the watershed condition. When these needs are met, many of the problems that result in damage to the region's resources and economic loss will have been solved or considerably modified. The means to accomplish watershed protection is discussed in terms of individual items on the basis of 1969 dollars.

Improved management of soil and water resources could lead to an increase in the production from cropland, range, and forest land. The greatest potential increase in cropland will come from improved technology in the use of fertilizers and improved irrigation systems to allow wider diversification of crops. The potential increase on rangelands will result from improvement in feed production and range management, increasing the carrying capacities of ranges. Forest improvement potentials are based on wider use of fertilizers, improved tree strains, and other cropping practices once considered useful only on agricultural areas.

Erosion that produces sediment pollution in streams and damages urban areas can be reduced as much as 90 percent by soil conservation measures without materially changing the basic land use pattern. Reforestation, gully control, and land treatment measures have been effective in reducing erosion and providing for stabilization of sand dunes. Other measures are river bank control and roadside fill and cut bank stabilization. These are discussed in greater detail in the cropland, forest land, and rangeland sections.

The solution to many of the conservation problems will require the cooperation of local organizations and Federal and State governments in planning and carrying out improvements for flood prevention and/or for the conservation, development, utilization, and disposal of water in watershed or subwatershed areas. The public agencies provide technical, financial, and credit assistance to landowners, operators, and other people living in the watersheds. Project-type action would supplement other soil and water conservation programs for the development and protection of our resources and flood protection for urban areas. A Conservation Needs Inventory and a river basin survey were made on the basis of small watershed areas, usually less than 250,000 acres. The Columbia-North Pacific Region was divided into 1,584 small areas and 908 were found to have problems and potentials of such a nature that they should be treated as a unit. Tables 32 and 33 show, by subregion and target date, the watersheds and acreage needing cooperative development and treatment. Figure 4, a dot map, shows the general location of these areas. Some of the small watersheds have been studied in detail, but only a limited amount of information has been obtained for many of them. Further detailed investigations will be necessary to determine exact needs and solutions to the problems.



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

WATERSHEDS NEEDING ACCELERATED DEVELOPMENT 1966-2020

THE REGION

1968

FIGURE 4

Table 32 - Study Areas with Conservation Problems Needing Cooperative Development and Treatment, The Region

Subregion & Target Year	Water-sheds	Number of Watersheds with Problems in: Flooding	Erosion	Drainage	Irrigation	Land Treatment
1980						
1	29	28	14	28	12	29
2	10	9	10	3	5	10
3	11	11	11	11	10	11
4	25	20	23	21	20	23
5	19	18	12	15	16	18
6	9	8	7	7	9	9
7	18	14	15	9	16	17
8	24	24	21	24	22	23
9	26	20	-	11	19	26
10	26	26	17	25	26	26
11	25	25	20	25	25	25
12	-	-	-	-	-	-
Total	222	203	150	179	180	217
2000						
1	46	43	13	38	17	46
2	28	25	21	8	25	28
3	6	6	6	6	6	6
4	33	28	29	25	27	31
5	29	26	24	24	29	29
6	36	28	33	30	32	36
7	20	16	18	11	20	19
8	13	13	13	13	13	13
9	23	23	8	23	23	23
10	31	31	22	30	26	31
11	59	35	22	49	35	49
12	12	12	12	12	12	12
Total	336	286	221	269	265	323
2020						
1	50	36	10	39	14	48
2	65	36	44	19	51	52
3	7	1	1	2	4	2
4	41	24	36	19	33	38
5	47	29	36	32	43	43
6	17	12	14	10	15	17
7	29	15	21	7	29	22
8	7	1	3	5	5	5
9	23	23	10	23	23	23
10	34	24	16	25	20	28
11	26	18	14	21	15	21
12	4	4	4	4	4	4
Total	350	223	209	206	256	303

Source: Soil Conservation Service, River Basin Data.

Table 33 - Practices Required for Cooperative Conservation Development, The Region

Subregion & Target Date	Water-sheds	Flood Control	Erosion Control	Drainage	Potential Irrigation	Water Short	Land Treatment
				(1,000 acres)			
1980							
1	29	40.5	101.8	45.1	66.3	23.6	131.5
2	10	35.8	349.4	3.2	119.5	9.2	352.6
3	11	59.7	8.3	31.7	142.0	16.0	99.7
4	25	159.1	535.3	93.7	155.7	71.4	1,033.4
5	19	11.9	134.8	16.3	105.8	80.7	186.6
6	9	10.8	195.7	6.8	35.5	11.9	410.1
7	18	31.2	473.7	8.6	468.5	109.4	488.7
8	24	38.9	3.3	45.5	51.2	0.5	87.7
9	26	35.7	-	202.2	278.6	3.4	251.0
10	26	75.9	128.3	64.5	127.3	4.1	206.9
11	25	179.3	5.6	160.1	114.6	-	345.0
12	-	-	-	-	-	-	-
Total	222	678.8	1,936.2	677.7	1,665.0	330.2	3,593.2
2000							
1	46	63.9	135.6	89.0	202.8	37.0	166.5
2	28	22.4	232.0	11.9	276.2	5.7	243.8
3	6	7.5	2.2	7.3	78.6	5.5	17.0
4	33	109.4	605.2	150.7	182.9	169.7	1,055.1
5	29	43.5	818.5	144.2	212.6	86.4	642.6
6	36	98.5	952.6	97.5	277.4	73.8	1,987.1
7	20	12.9	305.1	10.2	679.2	112.9	318.3
8	13	34.2	6.4	40.2	45.0	0.9	80.8
9	23	26.6	0.7	86.7	142.2	2.9	87.4
10	31	69.8	164.0	102.5	81.0	16.7	270.5
11	59	67.8	7.9	63.5	117.3	-	139.2
12	12	128.4	327.9	121.9	133.5	203.8	465.3
Total	336	684.9	3,558.1	925.6	2,428.7	715.3	5,473.6
2020							
1	50	70.7	72.4	95.5	112.8	45.3	109.6
2	65	54.3	888.0	34.6	1,309.9	22.4	922.6
3	7	6.0	0.4	0.9	54.0	Tr.	7.3
4	41	97.1	750.2	65.4	444.6	137.1	1,092.5
5	47	12.4	925.2	36.2	541.2	79.5	546.4
6	17	9.8	176.5	12.1	125.3	5.7	330.2
7	29	8.1	478.6	2.0	211.0	126.2	486.7
8	7	2.1	-	2.0	7.8	-	4.1
9	23	35.5	1.9	128.6	229.2	4.0	130.5
10	34	18.9	70.2	14.4	35.0	2.6	91.7
11	26	298.2	20.6	11.7	18.8	-	35.5
12	4	4.5	8.5	4.2	17.3	32.3	13.3
Total	350	617.6	3,392.5	407.6	3,106.9	455.1	3,770.4

Source: Soil Conservation Service, River Basin Survey Data.

Cropland

Presently, there are more than 20.8 million acres of cropland, with 7.1 million acres irrigated. Based on the projected needs for agricultural products, cropland should increase to just over 21.6 million acres with irrigated cropland expanding to about 13.1 million acres. The land resource is more than able to meet this demand for additional cropland. Table 34 indicates the amounts and distribution of land suitable for crop production.

Table 34 - Land Areas Suitable for Crop Production
The Columbia-North Pacific Region, 1966

Sub-region	Capability Class1/ I	II	III	IV	Total2/
	(1,000 acres)				
1	1.0	415.1	1,135.6	3,003.0	4,554.7
2	69.1	500.0	2,518.0	1,503.1	4,590.2
3	51.8	255.3	330.6	425.2	1,062.9
4	-	569.2	2,233.4	1,124.2	3,926.8
5	43.6	478.3	857.0	490.5	1,869.4
6	3.0	424.1	2,497.4	933.4	3,857.9
7	20.0	555.8	1,974.3	3,037.5	5,587.6
8	11.6	217.0	434.7	466.7	1,130.0
9	171.5	906.2	851.9	872.2	2,801.8
10	1.8	602.5	843.6	2,119.1	3,567.0
11	-	315.0	521.0	1,231.0	2,067.0
12	-	94.5	510.0	545.0	1,149.5
Total	373.4	5,333.0	14,707.5	15,750.9	36,164.8

1/ Defined in Appendix IV, Land & Mineral Resources
2/ About 15 million acres of desert land presently in land capability Class VI would also be suitable for crop production when irrigated.
Source: Appendix IV, Land and Mineral Resources

Water Conservation

The projected needs for food and fiber show that 13.1 million acres of cropland should be fully irrigated by the year 2020. This is an increase of over 5.9 million acres. In addition, over 26 percent or 1.8 million acres of irrigated cropland needs more than 2 million acre-feet of irrigation water to have a full season supply. Storage reservoirs and ground-water development, coupled with improved irrigation efficiencies, will be needed to meet the growing demand for agricultural water.

Irrigated agriculture is expected to continue to be the major consumptive user of water. As the competition for available water increases, irrigation needs will take on added importance and changes in the use of water for agricultural purposes are expected. Because of the increased cost of developing irrigation water, it is expected to use more systems with higher efficiencies. Irrigated soils and irrigation water will need to be used in a way that insures high production without wasting either water or soil. This means using cropping systems and management practices that will maintain a higher quality in agriculture.

There are a number of efficient methods of applying irrigation water. Sprinklers, furrows, corrugations, graded borders, and basins will give good efficiencies when properly used. The trend in the method of application to sprinkler irrigation is expected to continue. Much of the land coming under irrigation is expected to be equipped almost entirely by sprinklers (table 35).

Almost 1.9 million acres, or one-fourth of the total of 7 million acres irrigated, are irrigated with an acceptable efficiency. This means that the irrigation system is designed to deliver water in the right amount and at the right time, and that the farm operator is efficiently applying water according to plant needs.

Crop residue helps prevent soil erosion, increase infiltration, and maintain soil fertility. (SCS 9-15050)

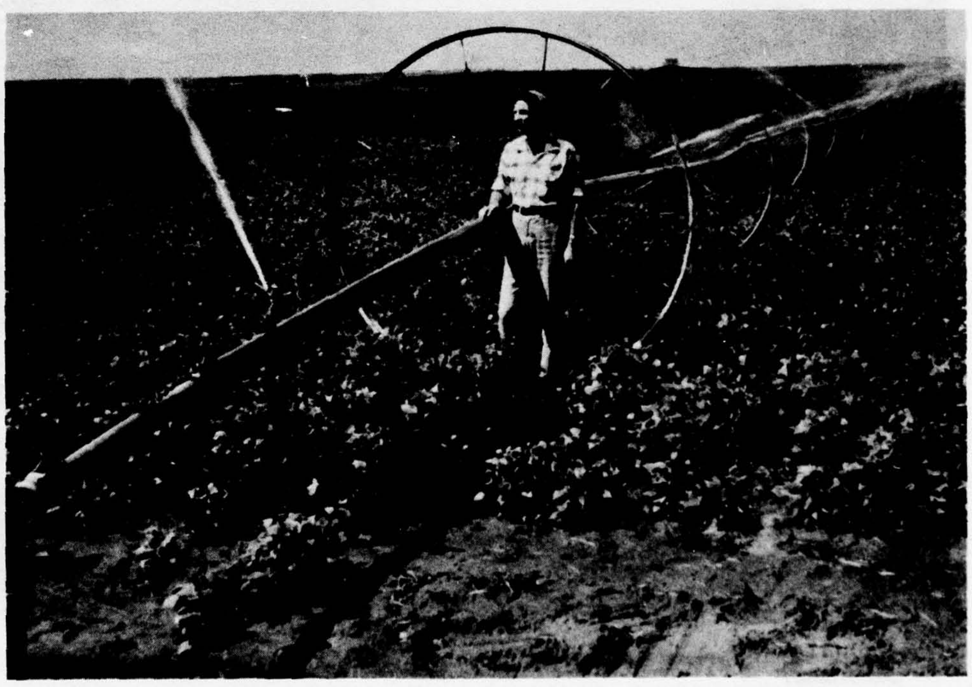
Table 35 - Probable Trend in the Method of Irrigation, The Region

Item	Unit	1966	1980	2000	2020
Sprinkler Irrigation Systems	No.	24,523	44,340	75,753	106,657
Area Irrigated	1000 Acs.	1,750	4,082	7,115	10,000
Surface Irrigation Systems	No.	27,448	23,790	20,130	15,850
Area Irrigated	1000 Acs.	5,381	4,662	3,946	3,106
Total Cropland Irrigated 1/	1000 Acs.	7,131	8,744	11,061	13,106

1/ Approximately 97 percent of Irrigated Area, Appendix IX, Irrigation.
Source: Soil Conservation Service, C-NPRBS Data

To properly manage all irrigated acres will require: (1) Conveyance systems to deliver water with minimum losses; (2) water control in surface irrigation; (3) full season irrigation water supplies for water-short areas; (4) adjustment in cropping practices to stay within water supplies; (5) technical assistance to farm operators in the management of irrigation systems.

One of the methods of increasing irrigated cropland acreage in local areas is to improve on-farm irrigation efficiencies. The application of better irrigation water management principals should



Sprinkler systems improve efficiency and wheels improve mobility, thereby reducing labor costs. (SCS W-1916-4)

increase on-farm irrigation efficiencies by about 8 percent or almost 0.6 acre-feet/acre. Savings effected for the 7.1 million acres presently irrigated would be almost 4.3 million acre-feet or enough to irrigate another 1.3 million acres in 2020.

The increases projected in on-farm efficiencies will require that irrigation be properly managed on almost 75 percent of the irrigated cropland or about 9.5 million acres by 2020. As is shown in table 36, this will require an increase of almost 110,000 water control structures, almost 25,000 miles of conveyance structures, 9,640 storage reservoirs, and land shaping on 1.6 million acres.

Table 36 - Cumulative Projected Practices for Irrigated Cropland, The Columbia-North Pacific Region

Practice	Unit	1966	1980	2000	2020
Water Control Facilities	No.	167,341	191,449	233,915	276,498
Irrigation Water Conveyance Facilities	Mi.	42,246	47,347	56,754	66,988
Water Storage Facilities	No.	7,996	10,110	14,500	17,640
Flood Irrigation System	No.	27,448	23,790	20,130	15,850
Sprinkler Irrigation Systems	No.	24,523	44,340	75,753	106,657
Land Shaping	1000 Acs.	1,413	1,783	2,422	3,034
Irrigation Water Mgt.	1000 Acs.	1,901	3,868	6,614	9,549

Source: Soil Conservation Service C-NPRBS Projections

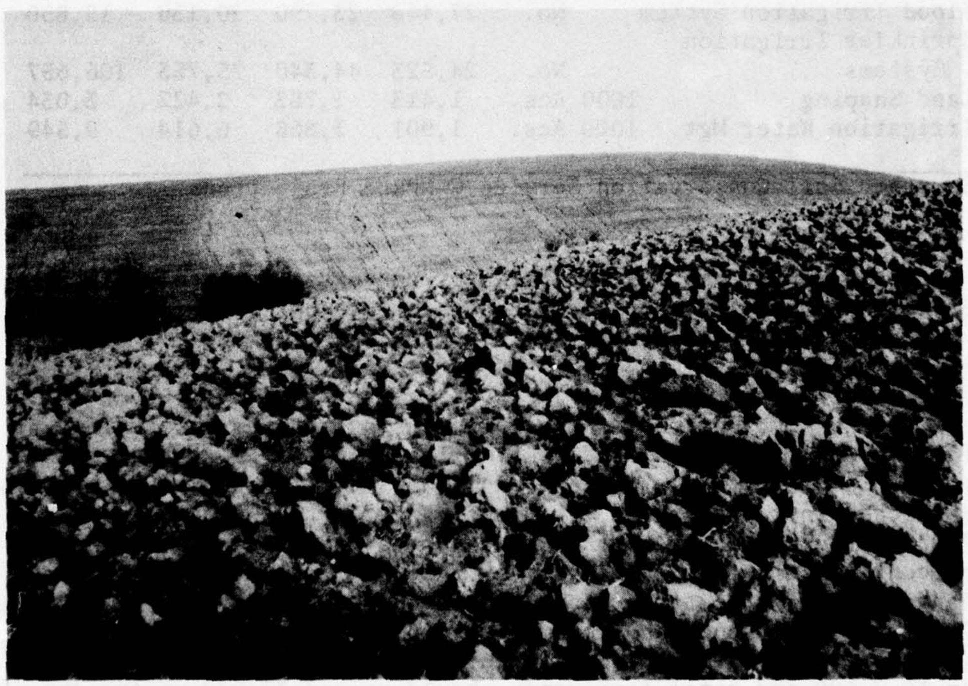
Currently the most acute water conservation problem is that 85 to 90 percent of the precipitation occurs between October 1 and May 31. Streamflows are at a minimum when the demand for water is maximum.

The most common method of increasing minimum streamflows or for meeting water requirements at critical times is storage reservoirs. Currently, there are over 1,700 small irrigation reservoirs and ponds in the region. These are expected to increase to over 4,200 by 2020. Total storage is expected to increase almost 70 percent. As shown in table 36, irrigation reservoirs on private land are projected to increase over 2,500 or 150 percent by 2020. Other types of ponds and reservoirs are also expected to increase. The number of multipurpose structures should expand by 112 percent or to 2,600 and total farm ponds should exceed 33,000 in the same period.

There is enough annual rainfall to produce many crops without irrigation, but only a little of it occurs during the growing season. Even in the moist climate west of the Cascades very few crops produce well without irrigation.

Several practices are used to conserve the natural moisture. The most widespread practice is to grow winter wheat, which is planted in the fall, grows a little during the winter, grows rapidly with spring moisture, and matures in the dry summer. Where there are less than 16 inches, the land is left fallow on alternate years and kept free of weeds to accumulate 2 years moisture in the root zone to produce a crop in the following year. The erosion control practices of fall chiseling, stubble mulching, subsoiling, strip-cropping, and diversions help the soil absorb water and hold it. General use of these practices will help meet the need for water conservation for dry land production.

Some large irrigation projects require cost sharing or, in the case of multipurpose dams, irrigation costs are reduced through the sale of power. However, although Federal loans can be obtained, some individuals or small groups pay for most or all of their irrigation developments. Programs to provide technical assistance, cost sharing equal to larger projects, and long-term, low-cost



Rough tillage leaves soil uncompacted, increases infiltration, and reduces runoff. (SCS 9-2137-3)

financing for the development of feasible projects should be improved and increased.

There are a number of possibilities that might meet this need. For example, states could provide for low interest loans to individuals or small groups and, in some instances, construct small projects. States should be encouraged to provide all of the needed financial assistance possible.

Drainage

Over 2.5 million acres or about 12 percent of the cropland has a wetness or drainage problem (table 22). About 845,000 acres of this have been drained to a degree suitable for the crop grown. By the year 2020, the drainage problem area will have increased by about 16 percent or to 2.9 million acres. Most of this increase will be in areas of irrigation expansion.

If cropland areas are to meet the projected food and fiber needs through increased yields, an estimated 75 percent of the cropland with a wetness problem will have to be drained by 2020 (table 37). Tile and open drains will be needed to remove excess surface and subsurface water since these drainage problems limit crop selection and reduce yield opportunities. Drainage practices will be applied to 1.2 million acres by 1980, almost 1.7 million by 2000, and 2.1 million by the year 2020. Table 38 shows the projected rate at which drainage practices should be installed. Current programs should be expanded to meet needs.

Table 37 - Cropland Areas Remaining to be Drained, Columbia-North Pacific Region

Subregion	1966	1980	2000	2020
	----------	----------	1000 acres ----------	----------
1	127.0	108.0	89.0	76.0
2	30.4	28.0	24.2	21.3
3	39.9	37.0	32.0	27.0
4	324.8	297.0	281.5	263.1
5	136.0	109.0	73.0	35.0
6	106.7	92.1	72.6	53.3
7	40.5	38.0	33.1	28.0
8	72.0	57.0	34.0	10.0
9	285.0	220.0	140.0	60.0
10	190.6	156.8	111.7	66.8
11	236.0	175.0	87.0	20.0
12	93.8	81.0	63.9	46.9
Total	1,682.7	1,398.9	1,042.0	707.4

Source: Soil Conservation Service, C-NPRBS Projections

Table 38 - Cumulative Practices Required to Provide Needed Drainage
Columbia-North Pacific Region

Practice	Unit	1966	1980	2000	2020
Conduits & Ditches	Miles	19,102	28,836	42,186	54,780
Structures	No.	3,477	5,644	7,769	12,096

Source: Soil Conservation Service, C-NPRBS Projections

Underground tile drainage systems remove excess water, making the land suitable for intensive use. (SCS 0-1443-11)

Erosion Control

Shifts in land use are expected to increase the cropland acreage with an erosion potential by about 12 percent or from 13.8 million acres to 15.5 million acres (table 27). To provide erosion control and protect water quality over 9.6 million acres of cropland will have been adequately treated by 1980, 11.9 million acres by 2000, and 13.9 million acres by 2020. Table 39 shows the area of cropland remaining to be treated.

Table 40 shows the erosion control practices, many of which are recurring, that will be necessary to treat cropland at the projected rate. These practices and the stream channel improvement practices shown in table 41 will reduce sediment yield from cropland areas by at least 63 percent by the year 2020. Annual sediment yield from cropland areas should decrease from 17,786 acre-feet in 1966 to 13,695 acre-feet by 1980, to 8,890 acre-feet by 2000, and to 6,580 acre-feet by the year 2020.

Table 39 - Cropland Areas Remaining to be Treated for Erosion Control, The Region

Subregion	1966	1980	2000	2020
	-----------------	--------1000 acres	----------	----------
1	222	162	101	42
2	1,277	995	402	192
3	11	8	5	3
4	1,630	1,450	1,269	1,029
5	413	330	220	110
6	1,263	982	606	231
7	864	720	369	18
8	10	5	3	1
9	7	5	3	1
10	32	26	17	8
11	17	14	11	2
12	8	7	5	3
Total	5,754	4,704	3,011	1,640

Source: Soil Conservation Service, C-NPRBS Projections

Table 40 - Cumulative Practices to Satisfy Erosion Control Needs on Cropland, Columbia-North Pacific Region

Practice	Unit	1966	1980	2000	2020
Grade Stab. Structure	No.	2,392	3,480	4,970	6,600
Diversions	Mi.	1,451	3,680	6,850	10,030
Ditch Bank Seeding	Mi.	3,025	3,970	5,150	6,330
Field Windbreaks	1000 Acs.	845	1,110	1,960	2,840
Crop Residue Use	1000 Acs.	5,704	8,010	10,940	14,110
Stubble Mulch	1000 Acs.	1,837	2,400	3,200	4,050
Grassed Waterway	1000 Acs.	67	360	460	1,160
Stripcropping	1000 Acs.	281	430	660	880
Cons. Cropping System	1000 Acs.	6,761	9,860	13,410	17,150
Pasture Planting	1000 Acs.	1,071	1,840	2,280	3,010

Source: Soil Conservation Service, C-NPRBS Projections

Erosion control on dry cropland is effected by planning and applying a combination of practices that protect the soil. These practices can be divided into three groups: structural, vegetative, and tillage. Structural practices include diversion terraces and floodways. Vegetative practices include critical area planting, ditch bank seeding, windbreaks, grassed waterways, and cover crops. Tillage practices include subsoiling, minimum tillage, stripcropping, and stubble mulching.

Practices to reduce erosion are used singly or in combinations based on the needs of the soil and crops grown. Capability Class II soils can usually be protected by use of simple tillage or cultural practices such as stubble mulching, growing cover crops or using minimum tillage. Capability Class III soils need tillage and cultural practices supplemented by practices such as stripcropping, diversion terraces, and grassed waterways. Cropland in Capability Class IV soils needs a combination of practices used on Class III soils with the addition of acceptable rotations and more intense management. Treating cropland according to its needs should reduce erosion to an acceptable level which is 5 tons per acre per year, or an inch of soil lost in approximately 100 years.

There are two ways to insure erosion control. One would be districts similar to weed control districts. In such districts, if a landowner neglected the erosion problem, the district would treat an eroding area by whatever means necessary to control the erosion and bill the landowner. Another means would be incentive payments. In this program, the landowner would receive incentive payments for seeding erodible areas to grass and legumes.

Field diversions remove excess water and prevent erosion. (SCS 5-2259-11)

Flood Control

Practices used to conserve soil have values in flood control by retarding flows and increasing the intake and storage of water by soils. For this reason, flood control should start on the land where the precipitation falls.

However, land treatment measures on cropland will have little effect on the extent of floods along the major streams. In general the largest portion of the flood waters arises from a source far removed from the cropland area in the upper watersheds on forest and rangelands. The runoff from agricultural lands causes erosion and sediment damage to stream and fields and adjacent improvements such as roads and irrigation ditches. Deposits in stream channels tend to restrict channel capacity and to aggravate meandering and bank cutting, thus increasing flood damages. Poor cropping practices often itensify excessive runoff and erosion. These losses can be greatly reduced and, in some cases, eliminated through proper cropping and conservation practices. To a large extent, the technical knowledge for improved practices exists, but the big problem is in getting them applied.

Table 41 shows the projected rate at which stream channel improvements and other flood prevention practices will be installed.

Table 41 - Cumulative Cropland Flood Prevention Practices, The Region

Practice	*1966*	*1980*	*2000*	*2020*
		(miles)		
Stream Channel Imp.	1,996	5,115	9,890	14,903
Streambank Protection	570	1,720	3,102	4,534
Stream Channel Stab.	84	457	970	1,529
Dikes & Levees	876	1,999	3,585	5,100

Source: Soil Conservation Service, C-NPRBS Projections

More details on flooding problems and the means to solve them can be found in Appendix VII, *Flood Control*.

Sometimes, damages to land and crops will not support extensive flood prevention work on an individual owner basis. Since erosion from cropland or streambanks usually causes sediment damage on downstream areas, programs need broader area coverage.

Conservation Costs

Table 42 shows the projected costs of the conservation program by target dates.

Table 42 - Estimated Cost of Cropland Conservation Practices, The Region

Item	Water Conservation	Drainage	Erosion Control	Flood Control	Total
			(1,000 dollars)		
1966-1980					
Private Funds	1,894,810	130,090	785,560	71,330	2,881,790
Public Funds	407,640	60,460	79,350	115,630	663,080
Technical Cost 1/	70,500	26,830	57,800	14,200	169,330
Total	2,372,950	217,380	922,710	201,160	3,714,200
1981-2000					
Private Funds	4,041,950	256,860	1,261,210	126,380	5,686,400
Public Funds	803,400	84,240	121,850	233,360	1,242,850
Technical Cost 1/	151,300	49,200	110,620	25,520	336,640
Total	4,996,650	390,300	1,493,680	385,260	7,265,890
2001-2020					
Private Funds	5,574,000	320,940	1,251,710	149,380	7,296,030
Public Funds	978,040	136,310	148,360	275,190	1,537,900
Technical Cost 1/	204,750	54,730	119,630	35,120	414,230
Total	6,756,790	511,980	1,519,700	459,690	9,248,160

1/ Includes public and private costs.
Source: Soil Conservation Service, C-NPRBS Projections

Programs

There are a number of existing technical and financial programs that can be used by the private landowner to help him implement needed land and water treatment.

The Agricultural Conservation Program can provide part of the cost of carrying out essential practices such as: Seeding for protection or land use adjustment; planting trees and shrubs to prevent erosion; establishing sod waterways, diversions, and terraces; streambank or shore protection and channel clearance; constructing open and closed drains; reorganizing irrigation systems;

land leveling for irrigation; lining irrigation ditches; constructing dams, pits, or ponds for agricultural uses; developing springs and installing pipelines for livestock water; controlling competitive shrubs on rangeland; subsoiling; developing wildlife habitat; and installing beautification-conservation measures.

An additional area of assistance could result from an acceleration or redirection of farmland diversion programs. These programs could be directed at solving conservation problems, as well as reduction of excess production.

The Small Reclamation Projects Act can be used to help finance, by loans, projects that are primarily for irrigation; but can include almost all other water uses if they are incidental to the main purpose.

The 1948 Flood Control Act can finance, construct, and give technical assistance to local governmental organizations for projects that are primarily for flood control, but other water functions can also be included as an incidental part.

Existing flood control acts provide authority for clearing and straightening streams and removal of snags and debris in the interest of flood control and navigation.

The Farmers Home Administration can make soil and water loans accompanied by technical management assistance to single or groups of owners or operators of farms and ranches to assist them in developing, conserving, and making proper use of their land and water resources. Water and waste disposal system loans and grants for the construction of rural community water and waste disposal systems are made to public bodies and nonprofit organizations. Similar loans can be made for the development of rural recreation areas including facilities for swimming, golfing, boating, fishing, and camping.

The Watershed Protection and Flood Prevention Act can be used by local governmental organizations of landowners to gain technical, cost-sharing, and credit aid in planning and carrying out works of improvement for flood prevention and agricultural land and water management, including irrigation and drainage. Also included, if not the major item in the plan, is nonagricultural water management, including municipal, domestic, and industrial supplies and fish, wildlife, and recreation development.

The Soil Conservation Act, Public Law 46, provides technical assistance through local Soil and Water Conservation Districts to individuals and groups of landowners or operators in all phases of conservation use and development of land and water resources.

The Food and Agricultural Act of 1960 provides for technical, cost-sharing, and credit aid to groups of landowners for planning and carrying out work for improvement of almost all water and related land uses. The agencies who administer the technical and financial assistance programs discussed above are shown in table 43.

Table 43 - Agencies Administering Programs Facilitating Land Measures and Watershed Protection on Cropland, The Region, 1968

Agencies and Programs	Loans	Cost Sharing	Technical Assistance
Agricultural Stabilization & Conservation Service			
Agriculture Conservation Program		X	
Bureau of Reclamation			
Small Reclamation Project Act	X		
Corps of Engineers			
Small Flood Control Act		X	X
Snagging & Clearing Act		X	X
Farmers Home Administration	X		X
Soil Conservation Service			
Resource Conservation & Development Projects	X	X	X
Watershed Protection & Flood Prevention Act	X	X	X
Soil Conservation Act			X

Forest Land

There is no substitute for proper watershed protection. The ultimate potential use of the forested areas cannot be realized unless the soil and water values are protected. There is also no advantage to planning the water resource development structural needs if land treatment on the upland watersheds is ignored. Watershed protection and land treatment go hand in hand with the utilization of the forest resources and the structural programs needed to develop the water resources of the region.

The demand for raw material by the forest products industries will require increased yields from the forest land of the region. Yield improvement practices will take many forms. Cultural

practices needing acceleration include the stocking of nonstocked and poorly stocked commercial areas, thinnings to increase per acre yields, pruning for better wood quality, and fertilization and tree improvement programs. Inventories of some of this cultural work and its cost have been made on most public ownerships. Projections have been made for the balance. These data are shown in table 44.

Harvest of the present and future forest mortality, located in the least accessible areas of the forest, will require accelerated access road construction. This means that higher levels of watershed protection will be required concurrently with this increased development. Demands on the water resources will require improved quality and quantity. This in turn will necessitate accelerated methods of sediment reduction and improved streamflows through water yield improvement.

Effective livestock control will need to be extended to all grazed forest lands. The extension of improved grazing systems to all the forest grazing land will require measures such as fencing, watering facilities, and added emphasis on the reduction of excessive grazing use if adequate watershed protection is to be achieved. The application of these practices will insure that watershed protection objectives are met and that livestock production remains an important use of forest land.

Table 44 - Projected Timber Culture Practices, Forest Land, Columbia-North Pacific Region

Program	1980		2000		2020	
	Amount (acres)	Cost 1/ ($1,000)	Amount (acres)	Cost 1/ ($1,000)	Amount (acres)	Cost 1/ ($1,000)
FEDERAL LANDS						
Reforestation	386,000	20,410	487,000	26,223	433,000	24,283
Timber Stand Imp. 2/	1,148,000	46,390	1,493,000	60,430	1,329,000	53,543
Other Practices 3/	573,500	4,866	653,500	5,189	146,000	2,654
Total Cost		71,666		91,842		80,480
NONFEDERAL LANDS 4/						
Reforestation	370,000	16,350	458,500	22,832	235,600	11,672
Timber Stand Imp.	460,000	17,755	530,000	22,340	214,000	7,860
Other Practices	530,000	7,320	575,000	9,352	345,000	6,272
Total Cost		41,425		54,524		25,804
TOTAL ALL LANDS						
Reforestation	756,000	38,760	945,500	49,055	668,600	35,955
Timber Stand Imp.	1,608,000	64,145	2,023,000	80,770	1,543,000	61,403
Other Practices	1,103,500	12,186	1,228,500	14,541	491,000	8,926
Total Cost		115,091		144,366		106,284

1/ In 1969 dollars.
2/ Includes thinning, pruning, and release.
3/ Includes fertilization, special burning, insect and disease control, and tree improvement.
4/ Includes technical assistance to private landowners.

Watershed Protection

It is expected that the level of watershed protection will parallel the increased multiple use activity of the forest land area. Each acre of forest land critically disturbed will require soil protection treatment. Skid trails and temporary roads will continue to need cross-drainage. Cable and tractor skid trails will continue to need seeding and scarification. Permanent roads will continue to need seeding, mulching, and possibly cribbing and matting of the cut and fill slopes. Paved roads will require improved ditch stabilization and additional culverts to handle increased runoff. Roads without permanent culverts will need reconstruction. Mining access development roads will require the same considerations. Spoil areas must be revegetated, stream pollution and acid drainage curbed, indiscriminate prospecting held in check. Livestock and big game populations must be adjusted to and kept in balance with the carrying capacity of the forest range. Recreation use that damages the resource cannot be tolerated. Development sites cannot intrude onto the landscape; they must blend in. Sewage treatment and other sanitary requirements must be considered as important as seeding roadsides or cross-ditching temporary roads.

In addition to these physical needs, the standards of operation on forest lands need equal consideration. Guidelines recently issued by the U. S. Department of Agriculture to reduce soil erosion and water pollution during construction on Federal lands and on federally assisted construction projects are equally useful in all private forest land management. Some of the more significant ones are:

1. Reduce by the greatest extent possible, the area and duration of exposure of readily erodible soils.

2. Time construction to avoid extremely rainy periods.

3. Trap construction sediment in temporary catch basins.

4. Mechanically retard runoff from construction sites during operating period.

5. Provide for the protection against such pollutants as chemicals, fuel lubricants, and sewage.

All these conditions to assure watershed protection must be considered in light of the demands for wood fiber, forage, minerals, and pure water from the forest lands of the region. Because these levels of treatment depend on the level of utilization or development, only broad estimates are made of this requirement and only general costs are developed. Table 45

outlines this as a total cost, accumulated through the year 2020. The costs are based on the assumption that (1) on the public forest lands, controls through current timber sale, road construction and other operation permits are adequate if properly applied, and (2) on the private forest lands, the minimum required in the year 2020 will be equivalent to that presently accomplished on the public lands.

Table 45 - Projected Costs for Watershed Protection Practices, Forest Land, The Region

Practices	Unit	Total Units1/	Total Cost1/ ($1,000)
PUBLIC FOREST LAND			
Logging Disturbance Treatment	Ac.	2,070,900	50,004
Harvest Road Treatment2/	Mi.	139,100	34,775
Other Watershed Requirements3/	Ac.	60,335,000	1,318,801
Total Cost			1,403,580
PRIVATE FOREST LAND			
Logging Disturbance Treatment	Ac.	1,235,600	25,272
Harvest Road Treatment	Mi.	102,400	20,480
Other Watershed Requirements	Ac.	24,257,000	657,796
Total Cost			703,548
TOTAL ALL LAND			
Logging Disturbance Treatment	Ac.	3,306,500	75,276
Harvest Road Treatment	Mi.	241,500	55,255
Other Watershed Requirements	Ac.	84,592,000	1,976,597
Total Cost			2,107,128

1/ Total for 55-year period 1965-2020. Costs in 1969 dollars.
2/ Includes road maintenance.
3/ Includes watershed surveys, plans, fire protection, timber cultural practices, and other indirectly related items.

At the rate shown in table 45, recurrent watershed protection measures will cost about $25,500,000 annually on the public forest lands and should cost $12,800,000 annually on the private. Most of the cost on the public lands is borne by the volume of timber being removed, and is usually deducted from the payment made by the purchaser for the timber purchased. As such, it is a cost to the public as public landowners. Private lands present a different problem, however. Some costs are borne entirely by the landowner. Others are shared by the landowners and the public through grants of matching money. On extremely critical areas outright grants of Federal funds are available for land treatment.

Table 45 shows the recurrent cost of these watershed protection programs, currently in effect or still needed. It is not the cost required to rehabilitate existing depleted watersheds. Converting the annual costs to totals, this amounts to slightly over 2.1 billion dollars or 43 cents per acre per year through 2020. It is the cost of the measures used or still required to maintain the condition of today's forest land under the increased pressures of tomorrow.

It should be kept in mind that the forest lands encompass an extremely large and complex area. Various types of forest land, various ownerships, various uses, and various short- and long-range goals are involved. Of prime consideration in recommending a comprehensive program of watershed protection are the costs of the proposed program and the benefits expected if such proposals are undertaken. This appendix shows the present and projected cost of watershed protection that, through past experience, has been considered a full requirement in forest land management. These are the requirements that both resource managers and public opinion indicate are a minimal necessity. Regionwide, this protection cost would amount to $38,300,000 annually and, based on potential sediment yield maps, will keep 36,000 acre-feet of sediment in place per year. This is soil that would remain on the land, out of the watercourses. Such protection would cost $880 per acre-foot or about $70 per acre-inch. Research is needed to properly measure the results of land treatment and only after additional study can this type of benefit be more properly assessed.

Research is also necessary to improve watershed protection systems. Land managers need to know of improved ways to retain soil in place. They need better logging systems, road construction methods, and mineral utilization processes. And finally, they need to know how to measure this accomplishment, ways that can be quantified other than the physical appearance of a free-flowing stream.

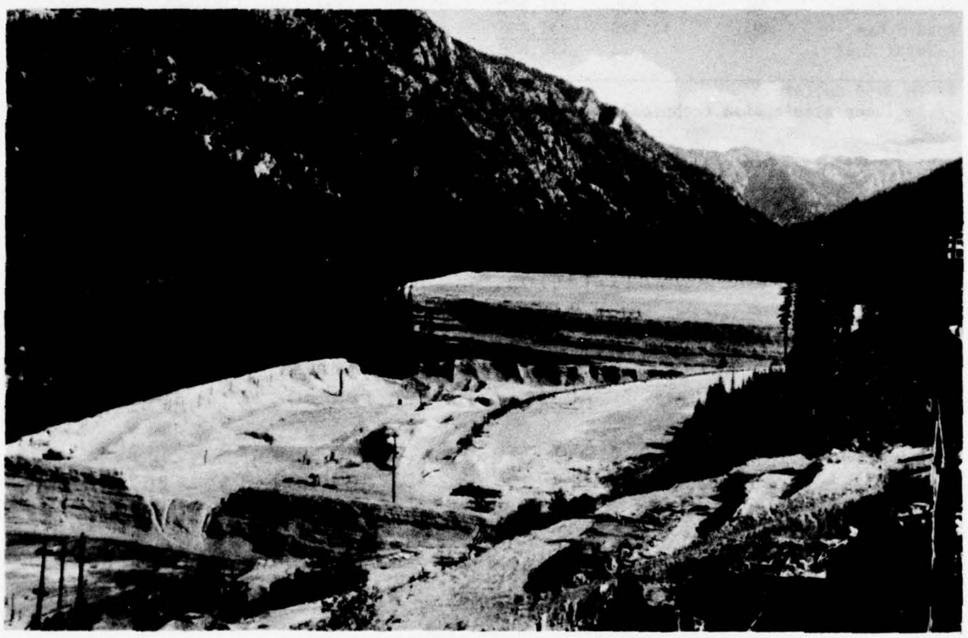
But even with the limited ability to quantify these results today, these requirements need to be put into effect now. While land managers can institute these measures on the public lands, they can only serve as examples for the private landowners. It will take education, legislation, and technical assistance to effect these improvements on the private sector. What is basically needed is state-sponsored legislation to enforce the state water quality standards. This legislation should properly interpret the water quality requirements as they affect the use of forest land. Such legislation could follow the general forest practices acts in effect in some of the states in the region. These require the landowner to properly reforest his cutover lands. A similar watershed practices act should set water quality standards for forest streams and require an operating plan that protects this resource

through compliance to these standards. It should also require the operator to leave his lands in a good hydrological condition just as the forest practices set requires him to reforest his cutover areas.

Watershed Rehabilitation

The condition of the forested watersheds varies considerably within the region and sediment yields range from very low to very high (tables 14 and 15). Generally, watersheds in the medium through very high sediment yield categories will receive attention first, although priorities will vary.

Some of the forest lands in the medium and high category are subalpine areas where glacial activity is predominant. In this area no corrective work is planned. It would be costly, it would conflict with the natural setting of the forest area, and it would probably not be effective. Other areas of concentrated high yields are scattered throughout all areas. These are spot areas where past land uses have had a serious effect on the land such as spoil areas from past mining activity.



Concentration waste from an abandoned mining operation. These settling basin areas are so sterile and high in acid concentration that they will not support vegetative growth. (Forest Service)

The forest land acreage presently requiring treatment and the amount that should be accomplished within time periods 1980, 2000, and 2020 are shown in table 46. Costs are tabulated in constant 1969 dollars. The average sediment reduction expected through the application of these measures is shown in table 47.

Table 46 - Projected Watershed Rehabilitation Programs, Forest Land, Columbia-North Pacific Region

Program	Unit	1980 Amount	1980 Cost 1/ ($1,000)	2000 Amount	2000 Cost 1/ ($1,000)	2020 Amount	2020 Cost 1/ ($1,000)
FEDERAL LANDS							
Land Treatment	Ac.	173,920	36,762	219.150	41,449	251,300	42,650
Stream Rehab.	Mi.	20,504	112,597	25,722	135,102	32,240	163,149
Road Rehab.	Mi.	11,431	11,770	6,557	4,189	3,960	1,274
Total Cost			161,129		180,740		207,073
NON-FEDERAL LANDS 2/							
Land Treatment	Ac.	335,750	11,188	378,500	13,996	388,800	14,279
Stream Rehab.	Mi.	2,201	23,365	1,563	9,344	1,715	14,435
Road Rehab.	Mi.	2,989	126	4,053	160	3,095	122
Total Cost			34,679		23,500		28,836
TOTAL ALL LANDS							
Land Treatment	Ac.	509,670	47,950	597,650	55,445	640,100	56,929
Stream Rehab.	Mi.	22,705	135,962	27,285	144,446	33,955	177,584
Road Rehab.	Mi.	14,420	11,896	10,610	4,349	7,055	1,396
Total Cost			195,808		204,240		235,909

1/ In 1969 dollars.
2/ Includes accelerated technical assistance to private landowners.

Table 47 - Expected Annual Sediment Reduction
Forest Land Rehabilitation, Columbia-North Pacific Region

Present Yields 1/	Acres (1,000)	Sed. Yield Ac-ft./Yr.	Acres 2/ Treated	Sediment Reduction Ac-ft./Yr.
Very Low	44,152.9	1,379.9	100,000	2.4
Low	37,712.0	5,892.5	1,639,000	207.1
Medium	2,986.6	933.4	1,440,000	405.1
High	846.1	661.0	697,000	435.6
Very High	145.9	342.0	146,000	296.4
	85,843.5	9,208.8		1,346.6

Total reduction, percent 15

1/ Data from tables 14 and 15 combined.
2/ Data from table 46. Miles treated converted to acres.

In addition to the needs for sediment reduction on the presently eroding forest lands, nonrecurrent work will be required on portions of forest areas suffering from such natural disasters as major forest fires or catastrophic windstorms. These natural events cause serious damage to forest land, account for heavy losses in commercial timber, and require extensive treatment before they become productive again.

Windstorms have toppled extensive areas of high-grade timber in the past. Besides the economic loss of the wood volume, large areas of ground are disturbed and major streams filled with logs and debris. These require a major amount of work to remove the debris and reopen the watercourses. This is a particularly serious problem in Subregions 8, 9, 10, and 11, where the streams are important to the anadromous fishery.

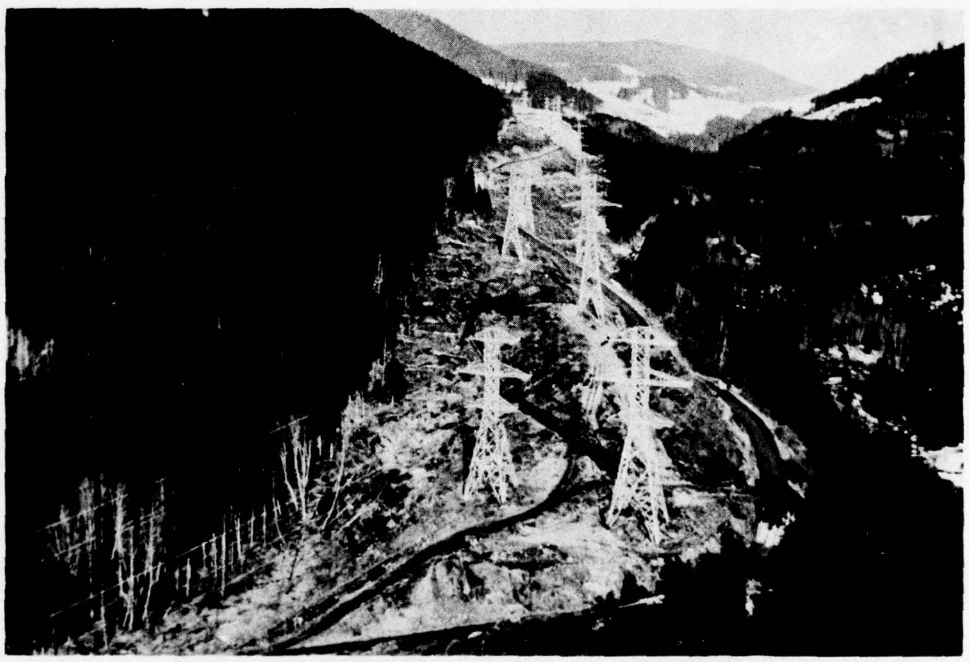
Major burns cause the greatest amount of rehabilitation work. Here again, there is the tremendous economic loss but, unlike the windstorms, there is a much greater soil and water loss. The burned-over areas require complete vegetative rehabilitation plus restoration of streams. This can be a tremendous undertaking as the following picture implies.

Burned-over area in northern Idaho. This area is typical of any large burn in the region. Revegetation, snag falling, and stream clearance work are all apparent needs in this picture. (Forest Service)

Other nonrecurrent work is generated with the construction of flood control, irrigation, and hydrologic projects. This work may take the form of reservoir shoreline stabilization, shoreline snag falling and stump removal, and the removal of floating debris from the reservoir surface.

Transmission line construction, generally a major part of any hydroelectric or thermal power project, can have a major impact on forest lands and their management. While sometimes disrupting the orderly timber harvest by dissecting the area with corridors, ground disturbance during construction is of greater concern. Full consideration of timber harvesting and slope steepness in line location and construction practices can minimize soil disturbance and vegetative destruction. Rapid rehabilitation of disturbed areas following construction is another immediate means.

Although direct projections usually cannot be made for any of the aforementioned work, trends of past needs and accomplishments can be analyzed and projected. These sediment sources will be treated as they occur. Therefore, the 15 percent overall sediment reduction is the amount possible excluding new sources occurring from catastrophic fire or other natural disaster.



Soil and vegetative disturbance under powerline construction. (Forest Service)

Water Yield Improvement

With 87 percent of the total runoff originating on the forest lands, any form of vegetative management that can favorably affect this flow is important. Cutting the forest canopy to increase snowpack and reduce snowmelt, fencing to accumulate snow, and maintaining the water table through water spreading, all hold promise.

The projected water yield improvement programs needed and the amount that should be accomplished within time periods 1980, 2000, and 2020 are listed in table 48. Cover manipulation includes cutting practices to increase snow accumulation, reduce snowmelt, and the removal of tree species using large amounts of water, replacing them with grass. Those species removed are generally in the noncommercial class. Snowpack management includes the construction of various types of barriers to help accumulate snow. These may be trees, fences or similar structures. Diverting water out of the stream channel onto more porous ground, ripping hardpan, or digging infiltration pits to increase ground water also improve timing of water yield. As most of the benefits of these measures accrue to the downstream user (irrigation, fish habitat, domestic water supply), the costs should not be borne wholly by the upstream landowners. Therefore, these practices are generally assumed most possible on the public forest lands until financial assistance is provided to private landowners.

Table 48 - Projected Water Yield Improvement Practices, Public Forest Land, Columbia-North Pacific Region

Program	Unit	1980 Amount	1980 Cost 1/ $1000	2000 Amount	2000 Cost 1/ $1000	2020 Amount	2020 Cost 1/ $1000
Cover Manipulation 2/	Ac.	73,470	2,242	158,720	4,227	189,270	4,396
Snowpack Management	Mi.	727	36,350	1,742	87,100	1,613	80,650
Water Spreading 3/	Ac.	35,375	2,225	54,500	3,019	57,700	2,787
Total Cost			40,817		94,346		87,833

1/ In 1969 dollars.
2/ Includes type conversion and riparian vegetation management.
3/ Planned for altering timing of runoff or ground-water recharge, not for irrigation or other resource activity.

Timber cutting practices may be adjusted somewhat on the private forest lands to increase flows. An example might be the forested uplands above an irrigation storage reservoir. If the

land and timber were owned by the irrigation district, and timber production was not a company-management goal, the removal of the timber could increase flows into the impoundment, provided a brush-free condition were maintained in the following years. This is one example where private forest holdings could be manipulated to increase water yields. Other than this, most private cutting follows a predetermined logging plan, not specifically designed to increase runoff. Therefore, neither treatment programs nor benefits have been calculated for the private forest lands although some benefit does occur.

Total Program Costs

The total estimated cost of the forest watershed protection and land treatment programs through the year 2020 may be expressed as follows:

	Costs ($1,000)
Watershed Protection	2,107,128
Watershed Rehabilitation	635,957
Water Yield Improvement	222,996
	2,966,081
Cost per year through 2020	53,900

Rangeland

Rangeland watershed problems were discussed in the "Present Status" section along with the range condition in 1966, as influenced both by past use and conservation practices accomplished through 1965. The "Future Needs" section gave an indication of demands for use of rangeland resources up to 2020, including range forage production and the diversion of present rangeland to cropland, urban development, and other uses. This in turn pointed up the future need, not only to rehabilitate previously damaged areas and to meet present watershed demands, but also to meet additional watershed requirements resulting from more intensive future multiple uses of the range.

An estimate of necessary measures and practices that will contribute to the attainment of desirable range watershed conditions by the year 2020 is presented in this section. Anticipated range condition has been projected to 2020, to show expected results of these efforts in conjunction with other nonwater oriented range management practices. Broad cost estimates have been developed for watershed protection and improvement.

Measures and Practices - 1966 to 2020

Requirements to meet future needs for rangeland watershed protection, rehabilitation, and improvement in the region are shown on tables 49 through 52. The tables also indicate major types of watershed problems which the given measures or practices are designed to improve or correct. Most of these measures and practices which improve drainage, conserve water, provide erosion and water quality control, and aid in reduction of flood and debris damage, also have other management objectives or purposes.

Some of these practices will have only modest benefit for watershed improvement and will be required primarily for improved forage production. At the other extreme, some will have watershed protection and rehabilitation as their major objective with only slight benefit for increased forage production. These latter requirements are generally for improvement of broad watershed areas and may have little or no direct benefit to specific individual private holdings. Consequently, the private operator cannot afford these costs and will need financial assistance and guidance to accomplish his part in this effort.

Cover Improvement and Soil Stabilization Cover improvement and soil stabilization work will be required on about 21.7 million acres of rangeland between 1966 and 2020. Because a combination of practices should be applied on certain of the range areas and a number of recurring measures are included, the combined total for this type of work amounts to 32.5 million acres of land treatment.

More than 9.4 million acres will need revegetation by establishment of grasses, legumes, forbs, and browse species to provide more ground cover for soil stabilization and to improve forage conditions for livestock and wildlife. This includes new area seeding of 6.1 million acres, and reseeding of 2.3 million acres. On deteriorated range areas with sedimentation and erosion problems, shrubs may be established on some 181,000 acres where there is sufficient moisture. An estimated 26 percent of the revegetation requirement is in Subregion 5, 23 percent in both Subregion 4 and Subregion 7, and 14 percent in Subregion 2. About 65 percent of the range seeding will be for watershed improvement and 35 percent for other management purposes.

Approximately 14.9 million acres will require brush control and replacement of the vegetation with a cover type that is more useful, protective, and erosion resistant. This includes initial brush control on 8.5 million acres and recurrent control on 6.4 million acres where desirable vegetation does not become established or where the recommended amortization period for seeding and spraying will be exceeded. More than three-fourths of the brush control is needed in Subregions 4, 5, and 7. Some 55 percent of these

Table 49 - Required Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, 1966 to 1980, Columbia-North Pacific Region

Measures & Practices	Units	Land Ownership Public 2/	Private	Total	Watershed Purposes 1/ (1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	2,222,100	1,124,700	3,346,800	-	x	x	x
Brush Control	Acres	2,865,800	1,288,800	4,154,600	-	x	x	-
Weed Control	Acres	621,200	645,200	1,266,400	-	x	x	-
Fertilizing	Acres	252,200	351,400	603,600	x	x	x	x
Conversion of tree cover to grass	Acres	34,600	8,000	42,600	-	x	x	x
Contouring, Pitting, Furrowing	Acres	304,400	265,700	570,100	x	x	x	x
Deep Tillage	Acres	21,100	27,300	48,400	x	x	x	-
Stream & Bank Stabilization	Acres	26,400	18,600	45,000	-	x	x	x
Waterspreading	Acres	33,700	50,100	83,800	x	x	x	x
Irrigation	Acres	1,800	2,200	4,000	-	x	x	-
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	33,600	39,600	73,200	-	x	x	-
Reducing Excessive Grazing Use	Acres	10,158,200	3,963,500	14,121,700	-	x	x	x
Livestock & Game Water Facilities	Number	14,300	9,300	23,600	-	x	x	x
Special Fire Control	Acres	3,527,200	1,494,200	5,021,400	x	x	x	x
Road Stabilization								
Existing roads	Miles	3,700	2,600	6,300	x	x	x	-
New roads	Miles	1,900	1,300	3,200	x	x	x	x
Abandoned roads	Miles	100	25	125	-	x	x	-
Stream Clearance	Miles	150	100	250	x	x	x	x
Pollution abatement	Miles	800	350	1,150	-	-	x	-
Water Control Structures								
Ponds & Small Reservoirs	Number	10,700	4,900	15,600	-	x	x	x
	Acre Ft.	54,700	15,700	70,400	-	x	x	x
Detentions	Number	500	400	900	x	x	x	x
	Cu . Yds.	753,400	665,100	1,418,500	x	x	x	x
Check Dams (Gully Plugs)	Number	22,100	9,800	31,900	-	x	x	x
	Cu. Yds.	1,295,100	654,800	1,949,900	-	x	x	x
Dikes	Lin. Ft.	158,400	110,100	268,500	x	x	x	x
Diversions	Number	250	250	500	x	x	x	x
	Cu. Yds.	549,800	541,900	1,091,700	x	x	x	x

1/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4-Flood & Debris Control.
2/ Includes Federal, state, county, and municipal ownership.
Source: Data collected from land management agencies specifically for the C-NP Study.

Table 50 - Required Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, 1980 to 2000, Columbia-North Pacific Region

Measures & Practices	Units	Land Ownership: Public 2/	Land Ownership: Private	Total	Watershed Purposes 1/ (1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	2,134,800	1,460,200	3,595,000	-	x	x	x
Brush Control	Acres	3,276,200	1,594,500	4,870,700	-	x	x	x
Weed Control	Acres	883,700	860,400	1,744,100	-	x	x	x
Fertilizing	Acres	267,800	256,200	524,000	-	x	x	-
Conversion of tree cover to grass	Acres	30,900	18,800	49,700	-	x	x	-
Contouring, Pitting, Furrowing	Acres	284,600	225,600	510,200	x	x	x	x
Deep Tillage	Acres	34,500	27,400	61,900	x	x	x	-
Stream & Bank Stabilization	Acres	56,800	33,600	90,400	-	-	x	x
Waterspreading	Acres	70,700	85,200	155,900	x	x	x	-
Irrigation	Acres	3,200	5,600	8,800	-	x	-	-
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	20,800	20,400	41,200	-	x	x	-
Reducing Excessive Grazing Use	Acres	888,900	1,066,300	1,955,200	-	x	x	x
Livestock & Game Water Facilities	Number	16,100	12,400	28,500	-	x	x	-
Special Fire Control	Acres	4,200,600	1,778,700	5,979,300	x	x	x	x
Road Stabilization								
Existing roads	Miles	4,700	3,000	7,700	x	x	x	x
New roads	Miles	1,600	900	2,500	x	x	x	x
Abandoned roads	Miles	250	100	350	-	x	x	x
Stream Clearance	Miles	175	75	250	x	x	x	x
Pollution Abatement	Miles	975	575	1,550	-	-	x	x
Water Control Structures								
Ponds & Small Reservoirs	Number	10,600	4,300	14,900	-	x	x	x
	Acre Ft.	59,300	16,400	75,700	-	x	x	x
Detentions	Number	550	350	900	x	x	x	-
	Cu. Yds.	958,400	896,500	1,854,900	x	x	x	-
Check Dams (Gully Plugs)	Number	27,600	12,400	40,000	-	x	x	x
	Cu. Yds.	1,164,700	757,600	1,922,300	-	x	x	x
Dikes	Lin. Ft.	270,100	139,000	409,100	x	x	x	x
Diversions	Number	275	225	500	x	x	x	x
	Cu. Yds.	508,800	462,900	971,700	x	x	x	x

1/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainge; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4-Flood & Debris Control.

2/ Includes Federal, state, county, and municipal ownership.

Source: Data collected from land management agencies specifically for the C-NP Study.

Table 51 - Required Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, 2000 to 2020, Columbia-North Pacific Region

Measures & Practices	Units	Land Ownership: Public 2/	Land Ownership: Private	Total	Watershed Purposes 1/ (1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	1,455,700	1,036,900	2,492,600	-	x	x	x
Brush Control	Acres	3,557,300	2,337,600	5,894,900	-	x	x	x
Weed Control	Acres	498,500	'395,200	893,700	-	x	x	x
Fertilizing	Acres	338,200	300,400	638,600	-	x	x	-
Conversion of tree cover to grass	Acres	48,000	37,300	85,300	-	x	x	x
Contouring, Pitting, Furrowing	Acres	252,000	139,900	391,900	-	x	x	x
Deep Tillage	Acres	31,600	22,100	53,700	x	x	x	-
Stream & Bank Stabilization	Acres	37,000	14,000	51,000	-	x	x	x
Waterspreading	Acres	69,800	112,400	182,200	-	x	x	-
Irrigation	Acres	5,600	11,800	17,400	x	x	x	x
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	17,900	15,700	33,600	-	x	x	-
Reducing Excessive Grazing Use	Acres	490,300	488,400	978,700	-	x	x	x
Livestock & Game Water Facilities	Number	15,800	13,900	29,700	-	x	x	x
Special Fire Control	Acres	4,767,900	1,809,800	6,577,700	-	x	x	x
Road Stabilization								
Existing roads	Miles	4,700	3,200	7,900	x	x	x	x
New roads	Miles	1,300	400	1,700	-	x	x	x
Abandoned roads	Miles	450	100	550	-	x	x	x
Stream Clearance	Miles	150	100	250	x	x	x	x
Pollution Abatement	Miles	750	350	1,100	-	-	x	x
Water Control Structures								
Ponds & Small Reservoirs	Number	10,500	4,600	15,100	-	x	x	x
	Acre Ft.	26,900	9,500	36,400	-	x	x	x
Detentions	Number	500	400	900	x	x	x	x
	Cu. Yds.	1,248,000	1,242,400	2,490,400	x	x	x	x
Check Dams (Gully Plugs)	Number	23,400	9,200	32,600	-	x	x	x
	Cu. Yds.	719,900	719,700	1,439,600	-	x	x	x
Dikes	Lin. Ft.	216,300	112,600	328,900	x	x	x	x
Diversions	Number	300	300	600	x	x	x	x
	Cu. Yds.	333,200	283,100	616,300	x	x	x	x

1/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4-Flood & Debris Control.

2/ Includes Federal, state, county, and municipal ownership.

Source: Data collected from land management agencies specifically for the C-NP Study.

Table 52 - Summary of Required Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, 1966 to 2020, Columbia-North Pacific Region

Measures or Practices	Units	Land Ownership: Public 2/	Land Ownership: Private	Total	Watershed Purposes 1/ (1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	5,812,600	3,621,800	9,434,400	-	x	x	x
Brush Control	Acres	9,699,300	5,220,900	14,920,200	-	x	x	x
Weed Control	Acres	2,003,400	1,900,800	3,904,200	-	x	x	x
Fertilizing	Acres	858,200	908,000	1,766,200	-	x	x	-
Conversion of tree cover to grass	Acres	113,500	64,100	177,600	-	x	x	x
Contouring, Pitting, Furrowing	Acres	841,000	631,200	1,472,200	x	x	x	x
Deep Tillage	Acres	87,200	76,800	164,000	x	x	x	-
Stream & Bank Stabilization	Acres	120,200	66,200	186,400	-	x	x	x
Waterspreading	Acres	174,200	247,700	421,900	x	x	x	x
Irrigation	Acres	10,600	19,600	30,200	-	x	-	-
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	72,200	75,800	148,000	-	x	x	-
Reducing Excessive Grazing Use	Acres	11,537,400	5,518,200	17,055,600	-	x	x	x
Livestock & Game Water Facilities	Number	46,200	35,600	81,800	-	x	x	x
Special Fire Control	Acres	12,495,700	5,082,700	17,578,400	x	x	x	x
Road Stabilization								
Existing roads	Miles	13,100	8,900	22,000	x	x	x	x
New roads	Miles	4,800	2,600	7,400	x	x	x	x
Abandoned roads	Miles	800	200	1,000	-	x	x	x
Stream Clearance	Miles	500	300	800	x	x	x	x
Pollution abatement	Miles	2,500	1,300	3,800	-	-	x	x
Water Control Structures								
Ponds & Small Reservoirs	Number	31,900	13,800	45,700	-	x	x	x
	Acre Feet	140,900	41,500	182,400	-	x	x	x
Detentions	Number	1,600	1,200	2,800	x	x	x	x
	Cu. Yds.	2,959,800	2,804,000	5,763,800	x	x	x	x
Check Dams (Gully Plugs)	Number	73,100	31,500	104,600	-	x	x	x
	Cu. Yds.	3,179,700	2,132,100	5,311,800	-	x	x	x
Dikes	Lin. Ft.	644,800	361,700	1,006,500	x	x	x	x
Diversions	Number	800	800	1,600	x	x	x	x
	Cu. Yds.	1,391,800	1,287,900	2,679,700	x	x	x	x

1/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col 4-Flood & Debris Control.

2/ Includes Federal, state, county, and municipal ownership.

Source: Data collected from land management agencies specifically for the C-NP Study.

efforts will be for watershed objectives, and 45 percent for other management purposes.

Weed control will be necessary on 3.9 million acres to replace inferior or injurious cover with vegetation that is more useful and protective. This includes 2.9 million acres of initial weed control and 1.0 million acres of recurrent work. About 1.8 million acres of rangeland will require fertilizing of nutrient-containing materials for improved forage production and increasing erosion resistant ground cover. More than two-thirds of the weed control acreage and fertilizing needs are in Subregions 2, 4, and 7.

Nearly 1.5 million acres should be contoured, pitted, or furrowed to give improved cover for soil stabilization. This includes 1.0 million acres where this practice will be applied for the first time and recurrent work on 500,000 acres. About 65 percent of this effort will be for watershed objectives while 35 percent is for other management purposes including increased forage production. More than half of this requirement is in Subregions 2 and 5.

Aerial spraying is a common method of brush control. (Bureau of Land Management)

Water should be spread on about 422,000 acres to increase the surface infiltration. Two-thirds of this requirement is in Subregions 2 and 7. In addition, some 30,200 acres should be irrigated, primarily in Subregion 7.

Approximately 6,700 miles of bank stabilization work should be accomplished along streams or reservoirs by revegetation and structural measures. Some 55 percent of this requirement is for erosion and water quality control, 25 percent for debris control and reduced flows, 5 percent for water conservation, and the remainder for other management purposes.

Other necessary cover improvement and soil stabilization practices include conversion of tree cover (primarily juniper) to grass or shrubs on 178,000 acres and deep tillage on about 164,000 acres. About half of this work will serve watershed protection objectives and half will be for increased range forage production

Watershed Oriented Land Management Practices Additional watershed and vegetation-soil surveys must be made to provide guidance and for more comprehensive rangeland watershed management. An estimated 19.9 million acres are presently covered by vegetation-soil surveys in rangeland areas of the Snake River Plains, the Columbia Plateau, and the Oregon Closed Basin. By 2020, such surveys should cover an additional 29.2 million acres. To update previous work and to measure management results, more intensive secondary surveys will be required on an estimated 43.5 million acres. Watershed management plans now cover about 15.3 million acres of rangeland. This should be increased to some 42.9 million acres by 2020 or 76 percent of the total range acreage.

Of major importance in improving rangeland watershed conditions is positive control of livestock distribution. Grazing use, excessive to the grazing capacity of the land, had been eliminated on about 30.3 million acres by 1966 (52 percent of the regional range area). Within the three future time periods, an additional 17.1 million acres will require adjustment to assure that grazing use is compatible with range condition and grazing capacity. Increased efforts should be directed to grazing management systems that increase range grazing capacity while providing adequate cover improvement and soil stabilization for watershed protection. The net result of these adjustments will be more livestock production and better use of range resources. More than half of the future adjustment is required in Subregion 5, although substantially better distribution is also needed in parts of Subregions 2, 4, and 7.

More than 148,000 miles of livestock fencing should be constructed between 1966 and 2020, including 116,000 miles of new fence and 32,000 miles of replacement fence. This will be needed for protection of conservation works, for rehabilitation of eroded

or deteriorated lands, for control of livestock in areas having primary value for fish and wildlife, and for grazing management. Subregions 1, 2, 4, 5, and 7 account for 92 percent of this requirement.

Some 82,000 livestock and game water facilities such as springs, wells, troughs, ponds, and guzzlers also should be developed for broader and more uniform distribution of livestock and game animals, conservation of existing water supplies, and preservation of the quality of water. About 55,200 new water facilities are needed and an estimated 26,600 facilities must be repaired or replaced. Nearly three-fourths of the livestock and game water facilities are needed in Subregions 2, 5, and 7.

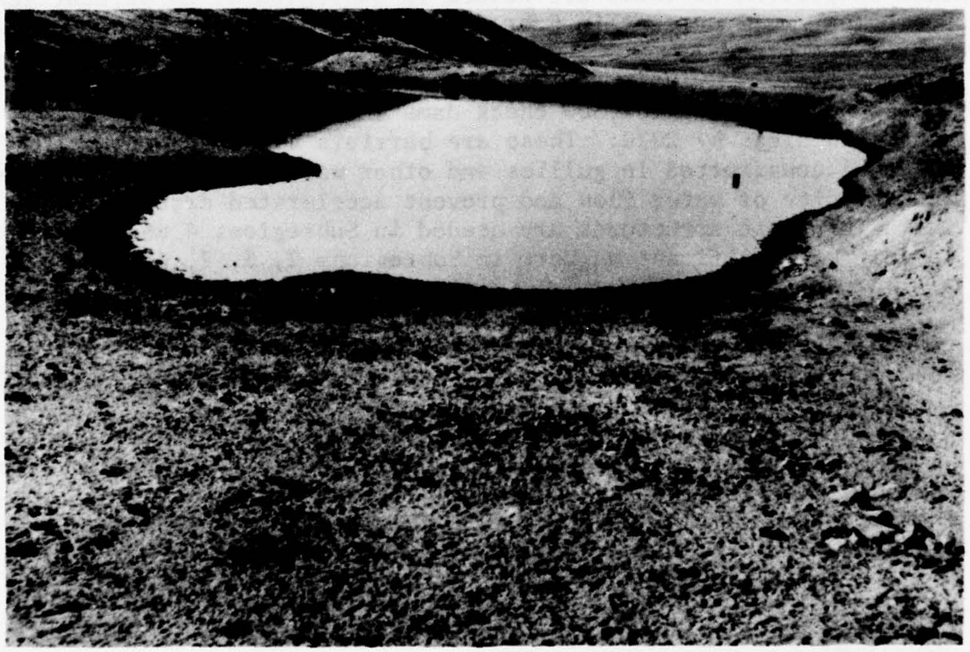
Uncontrolled range fires are a serious threat to range resources and the watershed. Present fire prevention and suppression programs of land management agencies and other organizations must be continued and, where necessary, additional financial assistance provided for early detection and control. Special fire prevention efforts will be required on about 17.6 million acres of rangeland, including extra fire patrol, fire breaks, conversion of vegetative cover to species with less fire hazard and lower suppression cost, and the development of facilities for fire control water supplies. These measures will help to preserve litter,

The area to the left of the fence, which is predominantly sagebrush and has inferior capability for watershed protection and forage production, has not been properly managed and shows evidence of erosion. The area to the right has had proper management and is predominantly grass covered. (Bureau of Land Management)

and to prevent siltation and water contamination caused by range fire. Access must be provided to present reservoirs or those constructed in the future so that water is readily available to fire equipment.

Considerable attention must be given to providing soil erosion protection in new road construction and in the continued use and maintenance of existing roads. On about 22,000 miles of existing rangeland access roads and trails, there will be need for ditches and culverts to control runoff; mulching, fertilizing, and seeding to protect cut banks and fill slopes; and protection of culvert outfalls. Similar attention will be required for an estimated 7,400 miles of new road construction along with added effort to prevent sediment damage to water courses during actual construction. Approximately 1,000 miles of abandoned roads will require such watershed rehabilitation work as waterbarring, scarification, and seeding in order to reestablish vegetative cover.

Stream clearance, including removal of debris, vegetation, and gravel bars from water courses to allow natural streamflow, is necessary along some 800 miles of waterways in rangeland areas. This will prevent streambank cutting and flood damage, and will allow passage of migratory fish to spawning grounds.



A number of ponds and small reservoirs should be developed on rangeland to conserve winter and spring water for subsequent livestock and wildlife use and to allow improved distribution of grazing use. (Bureau of Land Management)

Pollution abatement measures are needed along about 3,800 miles of streams and waterways to improve water quality and help attain required water quality standards (some one-third of these measures are recurring needs on the same river miles). These measures include such practices as restricting livestock use directly in streams and water supply sources, protecting streambanks to reduce sedimentation, and providing sanitary facilities for recreation use near streams, rivers, lakes, and reservoirs. Considerable additional study is necessary to identify deficient water quality areas and to develop adequate range management techniques that will attain desirable water quality levels.

Water Control Structures Water control structures required between 1966 and 2020 include an estimated 45,700 pounds and small reservoirs with a storage capacity of 182,400 acre-feet. Generally, these would be small water impoundments, such as ponds, tanks, retention dams, charcos, and pit reservoirs. More than 50 percent of these structures are needed in Subregion 5, 17 percent in Subregion 12, 10 percent in Subregion 7, and 9 percent in Subregion 4. Smaller numbers are required in the other subregions.

Some 2,800 detention structures are required for erosion and water quality control objectives and for water conservation. More than 33 percent of these are needed in Subregion 4, 25 percent in Subregion 2, 12 percent in Subregion 1, and 9 percent in both Subregions 6 and 7.

An estimated 104,600 check dams should be constructed on rangeland areas by 2020. These are barriers of earth or other material constructed in gullies and other water courses to decrease the velocity of water flow and prevent accelerated erosion. Two-thirds of these structures are needed in Subregions 4 and 5, with lesser but significant numbers in Subregions 2, 3, 7, 10, and 12.

An additional 191 miles of dikes will be required by 2020 to provide more range watershed protection. About half of this need is in Subregion 5 with lesser needs in Subregions 3, 7, and 12.

Other required structures include 1,600 water diversion dams, which raise water out of a defined channel and divert it to a water spreading area or into a reservoir. These are needed in most subregions which have a significant rangeland acreage, with the greatest requirements in Subregions 1, 5, 7, and 12.

Range Improvement - 1966 to 2020

Considerable rangeland improvement is anticipated between 1966 and 2020, both in terms of watershed rehabilitation and

protection, and in terms of the kind and amount of vegetation to meet future forage needs. This will result partly from the accomplishment of required measures and practices shown in tables 49 through 52, and partly from other nonwater related range management practices for improving livestock and wildlife use. Long-term range improvement of vegetation for forage and other uses will certainly be accompanied by improvement in watershed conditions.

Range Condition and Capacity The projected improvement in range condition through 2020 is shown on figure 5. These estimates are based on representative on-site surveys for production guides, with consideration of the capability of the range for improvement with proper management and utilization. Total rangeland acreage is projected to decrease about 4 percent, from 58.7 million acres in 1966, to 56.5 million acres in 2020, as it is diverted to other uses. In 1966, only 20 percent of the rangeland (including seeded areas) was in good range condition. With scheduled improvements, good condition range will be increased to 72 percent by 2020, or from 11.6 million acres in 1966, to 40.7 million acres in 2020. Poor condition range accounted for 37 percent of all rangeland in 1966. This will be decreased to 8 percent by 2020, or from 21.6 million acres in 1966, to 4.6 million acres in 2020.

The projected improvement in rangeland condition by subregion is shown on table 53. The area of good condition range is expected to increase by about 251 percent or 29.1 million acres between 1966 and 2020. Subregion 5 accounts for about 30 percent of this increase; Subregion 4, 27 percent; Subregion 12, 12 percent; and Subregion 7, 12 percent.

The regional grazing capacity is projected to increase 63 percent, from 7.3 million animal unit months in 1966, to 11.8 million animal unit months in 2020 (figure 5). The estimated trend in grazing capacity by subregion is given on table 54. Most subregions which have a significant acreage of rangeland show considerable improvement in grazing capacity. The average acreage required to support an animal unit month is expected to decrease from 8.1 acres in 1966, to 4.8 acres in 2020. Even with this significant improvement in the regional range condition and grazing capacity, range forage production will meet only about 6.1 percent of the demand for livestock production by 2020 compared to 9.3 percent in 1966.

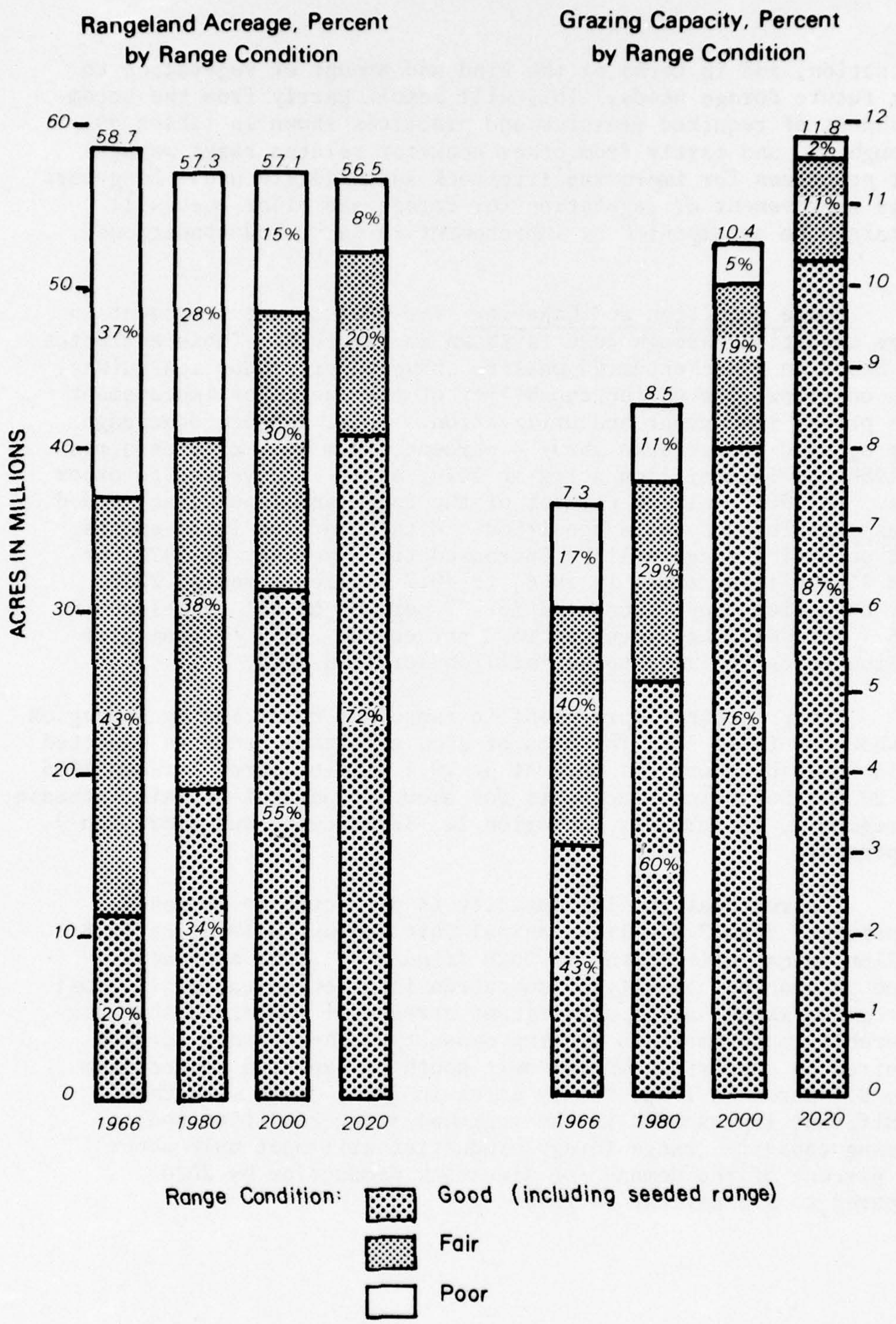


FIGURE 5. Estimated Potential Rangeland Improvement, Columbia-North Pacific Region

Table 53 - Estimated Potential Improvement in Rangeland Condition, by Subregion, Columbia-North Pacific Region

	Good Condition Range 1/			Fair Condition Range			Poor Condition Range		
	(1,000 acres)		Percent	(1,000 acres)		Percent	(1,000 acres)		Percent
Subregion	1966	2020	Change	1966	2020	Change	1966	2020	Change
1	440.3	920.3	+109	671.1	295.6	-56	586.7	214.4	-64
2	1,175.4	2,879.4	+145	1,542.9	438.7	-72	1,865.6	306.2	-84
3	383.7	788.2	+105	514.2	282.9	-45	636.9	181.5	-72
4	2,506.2	9,505.7	+279	8,575.3	2,066.6	-76	2,474.3	576.9	-77
5	2,675.2	11,724.6	+338	7,579.4	3,258.7	-57	6,584.1	1,218.1	-81
6	1,252.6	2,997.4	+139	2,085.9	1,003.8	-52	1,703.3	646.4	-62
7	1,227.6	4,595.4	+274	2,249.1	828.8	-63	2,881.4	398.9	-86
8	16.5	16.8	+ 2	19.9	20.4	+ 3	31.5	32.3	+ 3
9	12.7	13.5	+ 6	16.5	13.4	-19	29.6	21.0	-29
10	41.3	152.4	+269	37.6	47.2	+26	89.7	31.1	-65
11	17.7	15.5	- 12	36.8	32.2	-12	50.5	44.1	-13
12	1,857.6	5,494.6	+196	2,185.0	2,528.4	+16	4,690.5	838.2	-82
Total	11,606.8	39,103.8	+237	25,513.7	10,816.7	-58	21,624.1	4,509.1	-79
Percent of Total Rangeland	19.8	71.8		43.4	19.9		36.8	8.3	

1/ Includes seeded range areas.
Source: Figure 5 and subregional narrative sections.

Table 54 - Estimated Potential Improvement in Rangeland Grazing Capacity, by Subregion, Columbia-North Pacific Region

	Rangeland Area (1000 acres)			Animal Unit Months (1000 AUMs)			Average Acres/AUMs		
Subregion	1966	2020	Percent Change	1966	2020	Percent Change	1966	2020	Improvement %
1	1,698.1	1,430.3	-15.8	266.0	330.8	+ 24.4	6.4	4.3	69
2	4,583.9	3,624.3	-20.9	573.0	860.2	+ 50.1	8.0	4.2	90
3	1,534.8	1,252.6	-18.4	191.8	243.5	+ 26.9	8.0	5.1	57
4	13,555.8	12,149.2	-10.4	1,862.0	2,403.5	+ 29.1	7.3	5.1	43
5	16,838.7	16,201.4	- 3.8	1,433.5	2,433.2	+ 69.7	11.7	6.7	75
6	5,041.8	4,647.6	- 7.8	820.0	1,138.4	+ 38.8	6.1	4.1	49
7	6,358.1	5,823.1	- 8.4	955.4	1,758.3	+ 84.0	6.7	3.3	103
8	67.9	69.5	+ 2.4	12.9	13.0	+ 1.0	5.3	5.3	0
9	58.8	47.9	-18.5	13.5	13.7	+ 1.6	4.4	3.5	26
10	168.6	230.7	+36.8	22.9	58.9	+157.2	7.4	3.9	90
11	105.0	91.8	-12.6	15.2	13.3	- 12.6	6.9	6.9	0
12	8,733.1	8,861.2	+ 1.5	1,102.8	2,080.2	+ 88.6	7.9	4.3	88
Total	58,744.6	54,429.6	- 7.3	7,269.0	11,347.0	+ 56.1	8.1	4.8	69

Source: Figure 5 and subregional narrative sections.

Erosion and Sediment Yield The "Future Needs" section indicated that erosion and sedimentation was currently a significant problem on about 8.9 million acres of rangeland. This included some 3.4 million acres in the "Very High," "High" and "Medium" sediment yield categories shown on table 21, that account for only 5 percent of the range but produce 31 percent of the range sediment yield. The remaining 5.5 million acres is a part of the lands in the "Low" yield category, and reflects a number of smaller eroding areas in this generalized yield classification. The total acreage in the "Low" yield category accounts for a third of all rangeland and produces 38 percent of all rangeland sediment.

The measures and practices shown on tables 49 through 52 will be concentrated on these areas of higher sediment yield. Much of the erosion and sedimentation has been caused by past land use activities and range fires. Reduction or redistribution of grazing use on some areas and improved vegetative cover should result in a reduction of approximately 45 percent of the annual sediment yield, from 11,153 acre-feet in 1966, to 6,140 in 2020 (figure 6). The projected reduction in erosion and sedimentation is shown on table 55 for each subregion with most substantial improvement in the Middle and Lower Snake subregions.

Table 55 - Annual Sediment Yield Projections from Rangeland, by Subregion, Columbia-North Pacific Region

	(Acre-feet)					
Subregion	1966	1980	2000	2020	Change from 1966 to 2020	
					Total	Percent
1	497	407	300	208	-289	-58
2	709	630	525	394	-315	-44
3	157	147	135	120	- 37	-24
4	1,917	1,727	1,430	1,152	-765	-40
5	3,556	3,095	2,352	1,628	-1,928	-54
6	2,154	1,822	1,354	906	-1,248	-58
7	1,252	1,074	888	731	-521	-42
8	16	15	14	16	0	0
9	14	13	12	11	-3	-19
10	37	33	29	24	-13	-35
11	25	25	27	22	-3	-12
12	819	786	739	692	-127	-16
Total	11,153	9,774	7,805	5,904	-5,249	-47

Source: Figure 6 and subregional narrative sections.

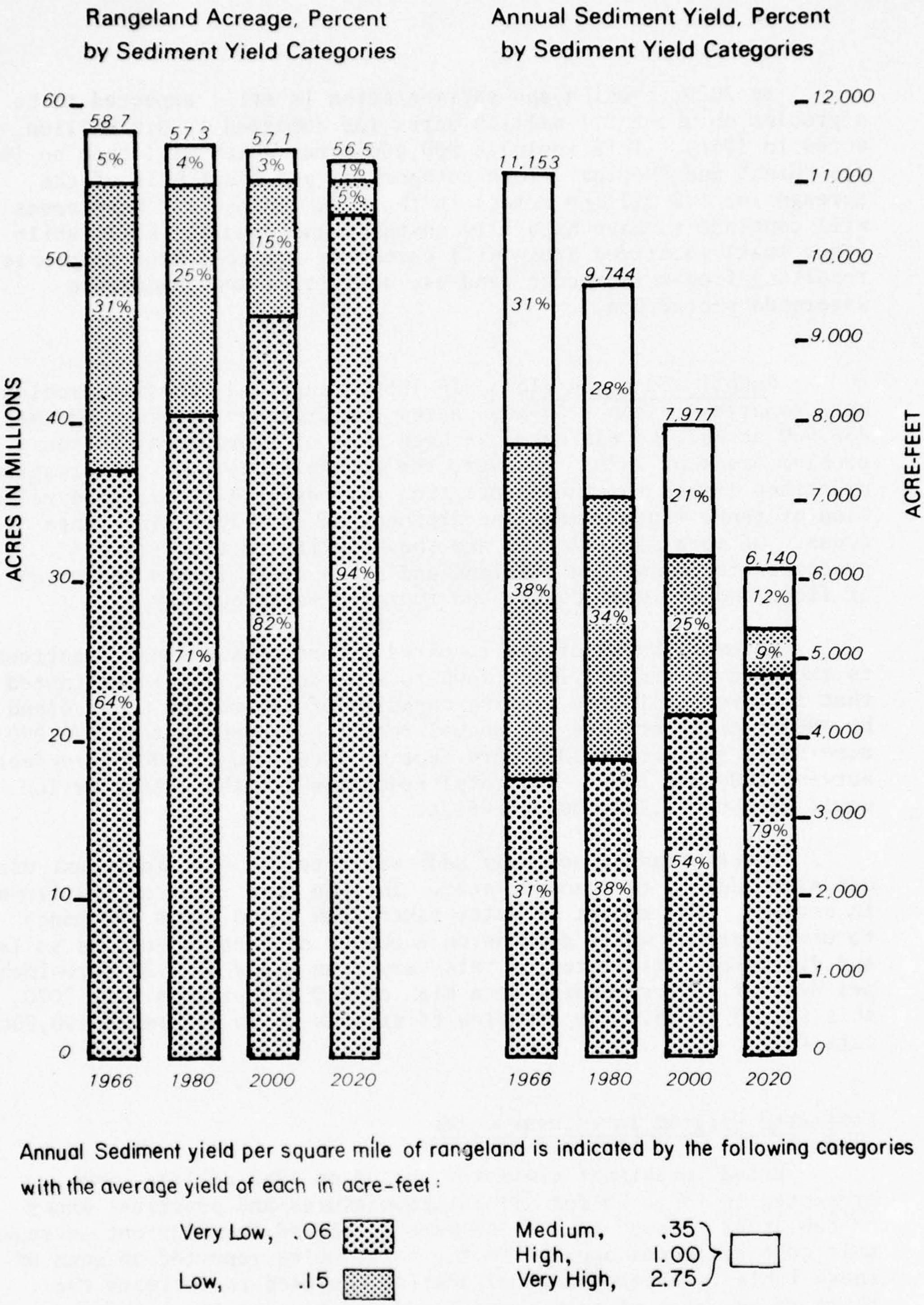


FIGURE 6. Sediment Yield Projections from Rangeland, Columbia-North Pacific Region

By 2020, erosion and sedimentation is still expected to be a problem on about 2.1 million acres (as compared to 8.9 million acres in 1966). This includes 900,000 acres which will then be in the "High" and "Medium" yield categories, and about half of the acreage (or 1.2 million acres) in the "Low" category. Many areas will continue to have naturally unstable and erodible soils while other small localized areas will encounter critical erosion problems resulting from more recent land use activities and inadequate watershed protection.

Runoff and Flood Flows In 1966, rangeland flooding problems were reported on about 309,000 acres and drainage problems on some 439,000 acres. No estimate has been made of improvement in these problem areas by 2020. However, the accomplishment of conservation practices listed for the future time periods will result in a reduction of range flood damage and drainage of some low-lying range areas. Of more significance are the benefits of these range practices to downstream cropland and urban areas in the reduction of flood and sediment damage and improved water quality.

Accomplishment of the required future measures and practices is expected to reduce flood flows to some degree. It is estimated that improvement in the grazing capacity of the region's rangeland by 1980 should decrease the annual runoff by approximately 370,000 acre-feet, another 545,000 acre-feet by 2000, and 350,000 acre-feet between 2000 and 2020. The total reduction for the entire period would be about 1,265,000 acre-feet.

Waterspreading not only adds water to the soil for plant use but also adds to the ground water. This in turn improves low flows in streams. The amount of water taken from flood flows and added to usable ground water depends on a number of factors such as soils and diversion. Estimates of this vary from a low of 0.25 acre-inch per acre of waterspreading to a high of 6.0 acre-inches. By 2020, this should improve the low flow of streams by an estimated 100,000 acre-feet.

Estimated Program Investment Costs

Broad investment estimates, based on 1969 dollars, are presented in table 56 for all future measures and practices shown on tables 48 through 51. These were developed from current average unit cost estimates applied to the total units reported on each of these tables. A percentage allocation was used to estimate the share of the cost of each measure and practice as it will serve specified watershed protection and rehabilitation objectives. These percentages were applied to total unit costs to compile watershed program costs. Those costs based on percentage benefit for nonwater related purposes have been excluded.

Table 56 - Estimated Cost of Required Measures and Practices for Watershed Protection and Rehabilitation of Rangeland by Major Types of Watershed Programs, Columbia-North Pacific Region

Major Types of Watershed Programs	1966 to 1980 ($1000)	1980 to 2000 ($1000)	2000 to 2020 ($1000)	Total ($1000)
		Public		
Cover Improvement and Soil Stabilization	42,042.5	60,982.7	45,906.3	148,931.5
Watershed Oriented Land Management Practices	15,802.4	13,046.7	12,975.5	41,824.6
Water Control Structures	13,277.9	14,259.0	13,937.4	41,474.3
Total	71,122.8	88,288.4	72,819.2	232,230.4
		Private		
Cover Improvement and Soil Stabilization	25,320.5	33,970.2	22,517.2	81,807.9
Watershed Oriented Land Management Practices	9,582.4	9,641.7	8,561.9	27,786.0
Water Control Structures	3,514.7	8,525.6	5,896.0	17,936.3
Total	38,417.6	52,137.5	36,975.1	127,530.2
		Total		
Cover Improvement and Soil Stabilization	67,363.0	94,952.9	68,423.5	230,739.4
Watershed Oriented Land Management Practices	25,384.8	22,688.4	21,537.4	69,610.6
Water Control Structures	16,792.6	22,784.6	19,833.4	59,410.6
Total	109,540.4	140,425.9	109,794.3	359,760.6

Source: Based on measures and practices shown on tables 49, 50, 51, and 52 with constant 1969 dollars.

No attempt has been made in this report to determine responsibility for funding required measures and practices for watershed improvement. Rather the approach has been to determine resource needs and means to satisfy them by identified public and private range areas. It is clear that many of the required practices are needed, not solely for improvement or rehabilitation of a specific land parcel, but for an entire watershed area and funding must be shared on a broad scale. In particular, private operators on private land cannot afford some of these requirements which have little direct benefit to their operations. Neither should they be required to stand the entire cost of watershed damage to their holdings caused by improper or inadequate upstream operations.

Cover improvement and soil stabilization programs will require $230.8 million for the three time periods. This is 64 percent of the total regional rangeland watershed program costs. Watershed oriented land management practices will cost $69.6 million or 19 percent of the total, and water control structures will require $59.4 million or 17 percent. Based on present rangeland ownership, an estimated $232.2 million (65 percent of total requirements) will be needed for publicly owned rangeland, while the private range will require $127.6 million or 35 percent.

About 58 percent of the projected rangeland watershed costs are required in Subregions 4 and 5 ($96.0 million for Subregion 4 and $112.0 million for Subregion 5). Subregion 2 accounts for another 15 percent or $52.4 million. Other subregions east of the Cascades represent 26 percent or $95.2 million, while the remaining 1 percent or $4.2 million is needed for the relatively small rangeland areas west of the Cascades.

Other Land

To a considerable extent, watershed protection and water supplies to meet future needs of urban and industrial areas, as well as roads and other special use areas, will be met by a combination of measures and practices on adjacent or upstream crop, forest, and range lands. Periodic flood and sediment damage will be allievated by proposals in these areas to stabilize soils and reduce excessive runoff and peak flows. Quality and quanity of water supplies will be improved by measures to increase infiltration rates, reduce sediment and pollution, and provide additional storage facilities to extend seasonal supplies. These are discussed in preceding parts of this section.

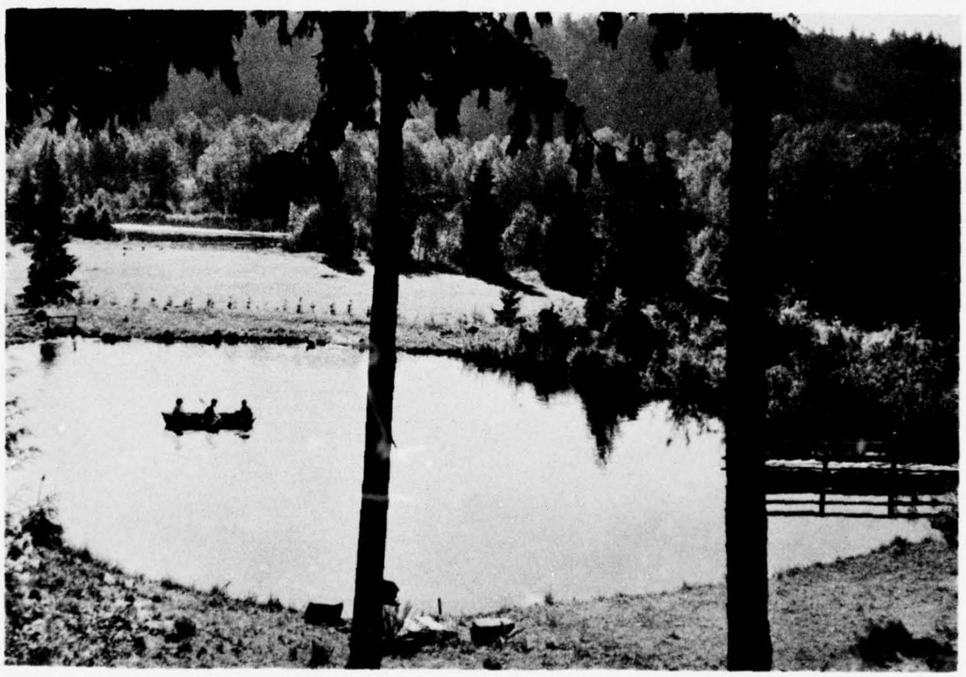
Proposed programs and costs are included in other sections of this appendix and in other functional appendices, particularly Appendices VII, Flood Control; IX, Irrigation; XI, Municial and Industrial Water Supply; and XII, Water Quality & Pollution Control. These will substantially improve watershed conditions and meet needs in the more intensive use areas of the other land category.

Coordinated comprehensive watershed planning by local, state, and Federal agencies is essential to meet these needs. Zoning authority must be extended and enforced to regulate type of development and to control design and construction. Efforts to control flooding and reduce resulting damage to urban and suburban areas include: (1) zoning, (2) flood proofing, (3) increased channel capacity, (4) construction of levees and floodwalls, (5) provision for protective vegetative cover, and (6) combinations of these measures. These measures must also control runoff and transportation sediment onto adjacent areas, principally cropland and

and highways. Increased attention must be directed to the multiple use of all present and future water storage facilities to serve urban and industrial needs.

Present problems of sediment deposits, excessive runoff, and flooding and drainage caused by construction and development in urban and industrial areas will be intensified by expansion of these uses onto some 700,000 acres of adjoining crop, forest, and range areas. Much of the 700,000 acres being converted will be a serious sediment source unless protected. Strict building codes, construction permits, etc., should require temporary revegetation or substitute cover during the construction period. Strict enforcement of state water quality standards will encourage this.

Road construction projects are a similar problem. Nearly 5,000 miles are under construction each year in the region. This results in the movement of large volumes of rock and earth. Generally revegetation and landscaping are a final part of the project, but little is done during the height of construction activity. Temporary mats, easily established annual grasses, and sediment control structures of native material, all serve this purpose. As with urban and industrial development projects, this requirement will help to maintain state water quality standards.



Farm ponds, an increasing type of other land use, are now providing recreational benefits along with their many other useful purposes. (SCS W-3683-5)

Overall, the acreage in barren lands, including rock outcrop and dune areas, will not change significantly by 2020. A number of coastal dunes and sand areas are subject to wind and tidal action and require stabilization practices. An estimated 7,500 acres of dunes along the coast should be stabilized by revegetation measures. Some 357,000 acres of additional sand areas require planting of grass or shrubs and drift fencing to reestablish vegetative cover where practicable and to prevent expansion of present sand areas. About half of this requirement is in Subregion 4, a fifth in Subregion 2, and nearly a fifth in Subregion 5.

S U B R E G I O N 1
C L A R K F O R K - K O O T E N A I - S P O K A N E

PRESENT STATUS

Subregion 1 is comprised of the upper drainage area of the Columbia River system from the headwaters in Montana to the confluence of the Spokane and Columbia rivers in Washington. It contains about 13 percent of the Columbia-North Pacific Region and encompasses an area of 23,271,000 acres, including 451,600 acres of large water bodies. About 63 percent is publicly owned, predominantly Federal. Over 85 percent of this is national forest. Cover and Land use are shown on figure 7.

Precipitation varies considerably with the season and elevation. With the exception of some small "rain shadow" areas in Montana, the lowest average annual precipitation is about 15 inches in the area west and southwest of Spokane. Several places in northern Idaho and northeastern Washington have annual totals of 50 inches or more. Along the west slopes of the northern Rocky Mountains in Montana annual totals are as high as 125 inches. In the northwestern parts of the subregion, a large proportion of the annual precipitation comes during the cold season in the form of snowfall. Spring rains on a melting snowpack can produce devastating flood flows. The most recent example occurred in June 1964 on the western slope of the Rocky Mountains in the vicinity of Glacier National Park. Snowmelt flooding occurs frequently on the Flathead and Kootenai River systems. Average discharge of streams originating in the subregion totals about 26.2 million acre-feet annually. About 94 percent of the runoff, 24.5 million acre-feet, is from forest land and the remaining 1.7 million acre-feet are from cropland and rangeland (figure 8).

The highest sediment yields are in the agricultural areas near Spokane, Washington, and below Flathead Lake in Montana. Other areas of temporary high yield may result from logging or grazing on some of the steeper mountain slopes (table 57 and figure 9).

Table 57 - Generalized Sediment Yield by Cover and Land Use, Subregion 1

Cover and Land Use	Acres (1,000)	Percent	Sediment Yield (ac-ft./year)	Percent
Cropland	1,552.1	7	1,472	40
Forest Land	18,242.1	80	1,366	37
Rangeland	1,698.1	7	497	14
Other Land	1,327.1	6	315	9
Total	22,819.4	100	3,650	100

Source: Derived from figures 4 and 6 and Appendix IV.

Cropland

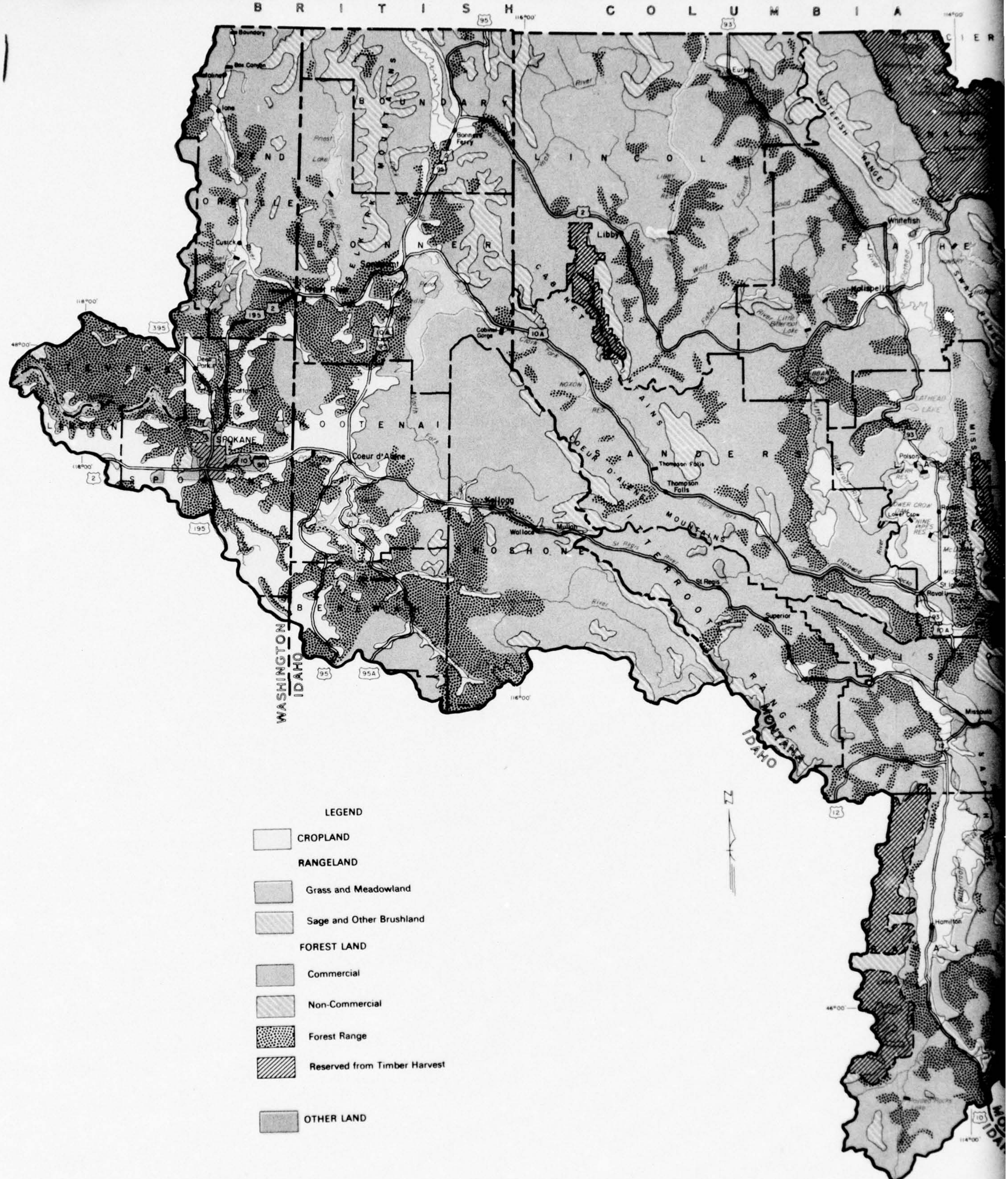
The total cropland acreage of about 1.6 million acres includes some 465,000 acres of irrigated land and 1.1 million acres of dry farm land (table 58).

Table 58 - Types of Crops, Subregion 1, 1966

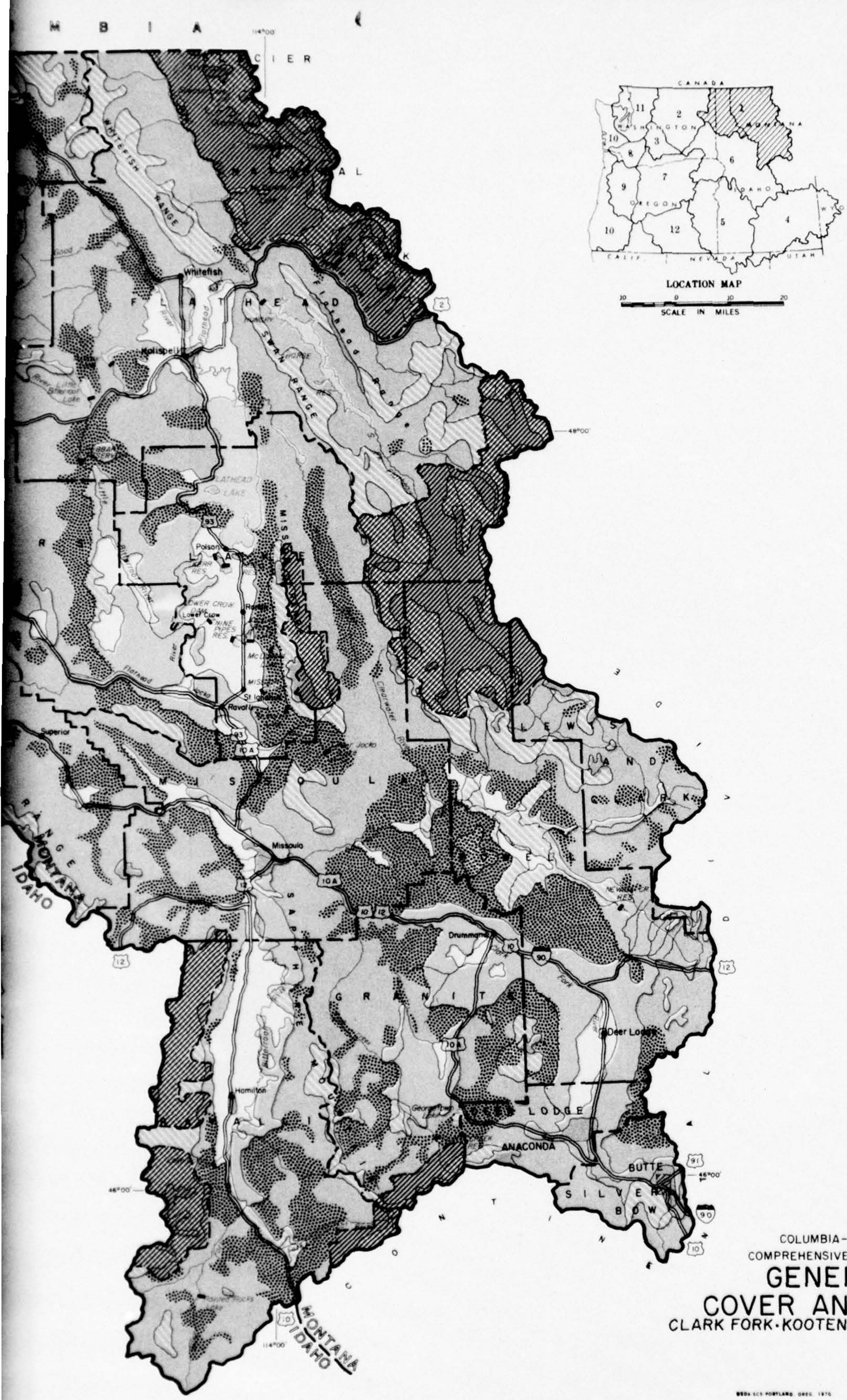
State	Hay and Pasture	Grain and Fallow	Grain	Other 1/	Total
	----------	----------	1000 Acres	----------	----------
Dry Cropland					
Montana	280.0	53.2	91.2	1.9	426.3
Idaho	103.7	26.7	66.9	71.5	268.8
Washington	122.3	213.7	--	56.4	392.4
Total	506.0	293.6	158.1	129.8	1,087.5
Irrigated Cropland					
Montana	370.0	--	37.8	9.3	417.1
Idaho	11.6	--	.3	11.6	23.5
Washington	10.2	--	1.9	11.9	24.0
Total	391.8	--	40.0	32.8	464.6
Total Cropland	897.8	293.6	198.1	162.6	1,552.1

1/ Includes peas, lentils, grass seed crops, potatoes, and fruit orchards.

Source: Appendix IV, Land and Mineral Resources.


B R I T I S H   C O L U M B I A
BOUNDARY
LINCOLN
FLATHEAD
BONNER
PEND OREILLE
KOOTENAI
SANDERS
SHOSHONE
BENEWAH
SPOKANE
SPOKANE
Coeur d'Alene
Kellogg
Libby
Kalispell
Whitefish
Thompson Falls
St Regis
Superior
Missoula
Hamilton
Polson
WHITEFISH RANGE
CABINET MOUNTAINS
COEUR D'ALENE MOUNTAINS
BITTERROOT RANGE
WASHINGTON
IDAHO
MONTANA
IDAHO
LEGEND
CROPLAND
RANGELAND
Grass and Meadowland
Sage and Other Brushland
FOREST LAND
Commercial
Non-Commercial
Forest Range
Reserved from Timber Harvest
OTHER LAND

2



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

GENERALIZED COVER AND LAND USE

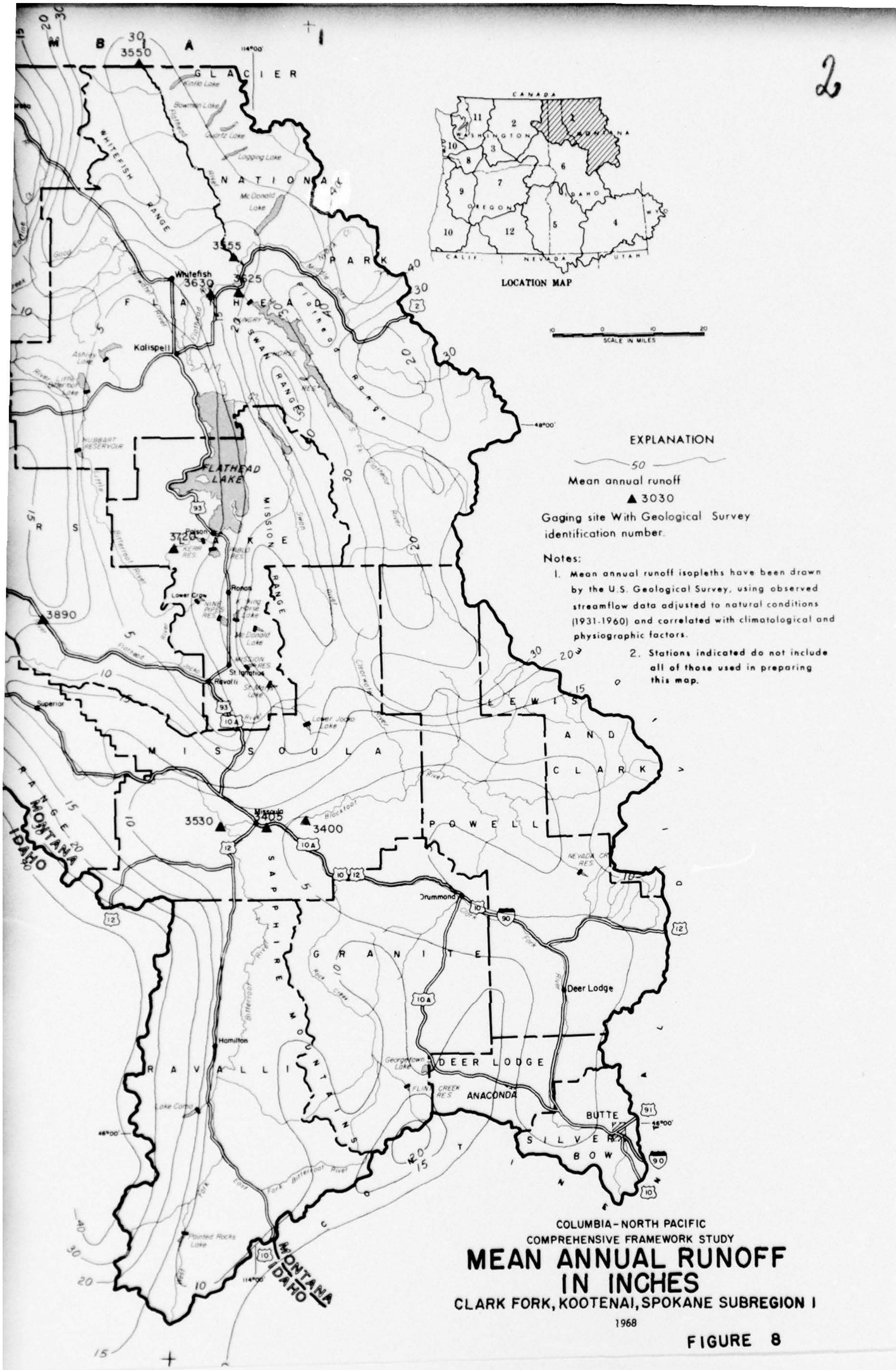
CLARK FORK·KOOTENAI·SPOKANE, SUBREGION I
1968

USDA-SCS-PORTLAND, OREG. 1970

FIGURE 7


BRITISH COLUMBIA
STEVENS
PEND OREILLE
BOUNDARY
BONNER
LINCOLN
SPOKANE
KOOTENAI
SHOSHONE
BENEWAH
SANDERS
FLATHEAD LAKE
RAVALLI
SELKIRK MOUNTAINS
CABINET MOUNTAINS
COEUR D'ALENE MOUNTAINS
BITTERROOT RANGE
WHITEFISH RANGE
WASHINGTON
IDAHO
MONTANA
Boundary
Metaline Falls
Box Canyon
Ione
Cusick
Calispell Lake
Newport
Priest River
Albeni Falls
Sandpoint
Bonners Ferry
Priest Lake
Pend Oreille Lake
Cabinet Gorge
Libby
LIBBY RES
Eureka
Whitefish
Kalispell
Ashley Lake
HUNGRY HORSE RES
Deer Park
Chattaroy
Spokane Lake
LITTLE FALLS DAM
SPOKANE
Post Falls
Coeur d'Alene
Coeur d'Alene Lake
Kellogg
Wallace
Mullan
St. Maries
St. Joe River
St. Regis
Superior
Thompson Falls
NOXON RES
Polson
KERR RES
Ronan
Lower Crow
NINE PIPES RES
McDonald Lake
St. Ignatius
Ravalli
Hamilton
Lake Como
Painted Rocks Lake
3985
3220
3075
3050
3030
3000
3550
3555
3630
3625
3966
3920
4135
3890
3720
3530
118°00'
116°00'
114°00'
48°00'
46°00'

2



EXPLANATION

50

Mean annual runoff

▲ 3030

Gaging site With Geological Survey identification number.

Notes:

1. Mean annual runoff isopleths have been drawn by the U.S. Geological Survey, using observed streamflow data adjusted to natural conditions (1931-1960) and correlated with climatological and physiographic factors.
2. Stations indicated do not include all of those used in preparing this map.

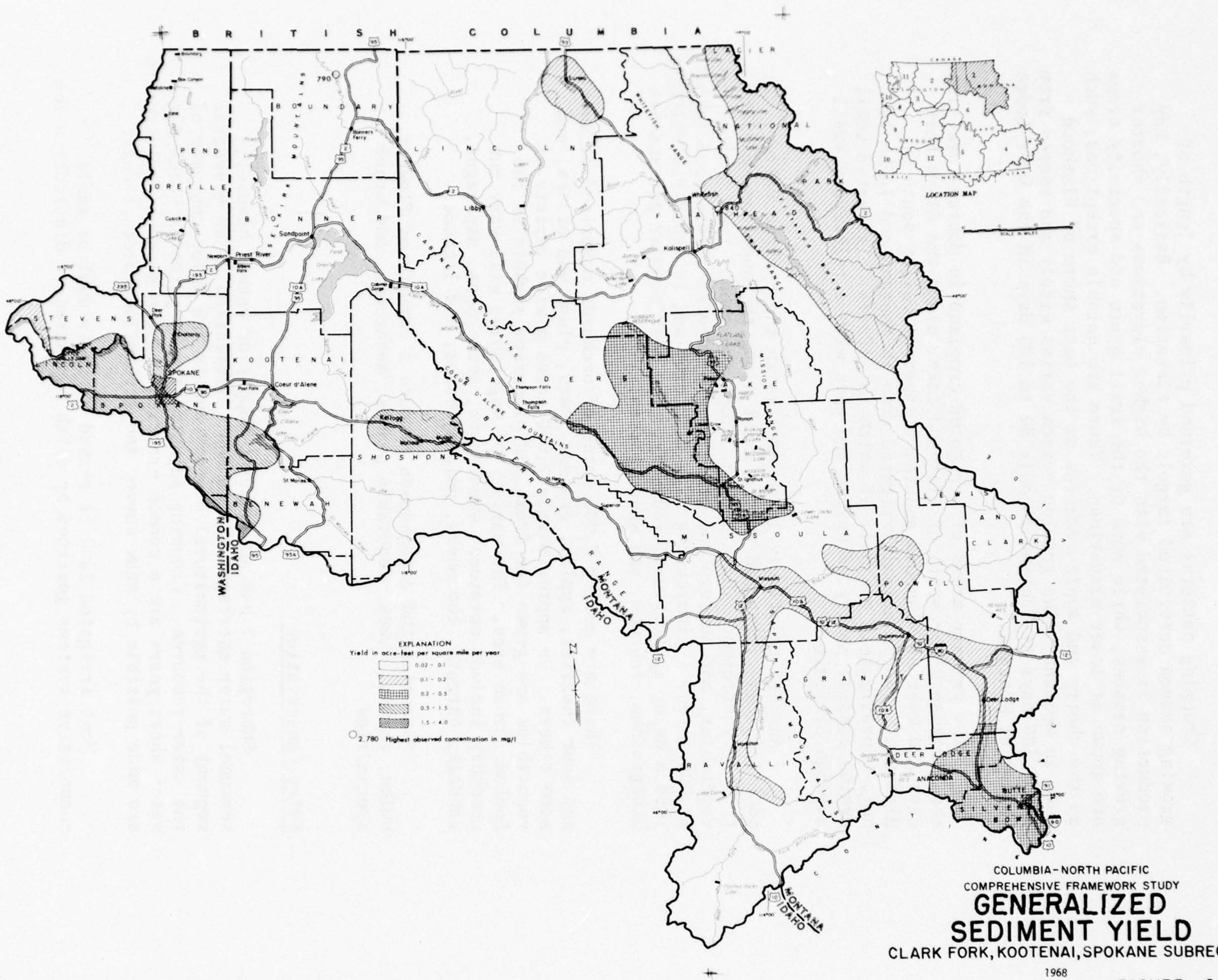
COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

MEAN ANNUAL RUNOFF IN INCHES

CLARK FORK, KOOTENAI, SPOKANE SUBREGION I

1968

FIGURE 8



COLUMBIA–NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

GENERALIZED SEDIMENT YIELD

CLARK FORK, KOOTENAI, SPOKANE SUBREGION I

1968

FIGURE 9

Cropping patterns are governed primarily by length of growing season determined largely by elevation. Basically, hay production is associated with the higher elevations and shorter growing seasons, while much of the small grain and specialty crops are grown at lower elevations. There are notable exceptions, such as the cherry and apple orchards on the east shore of Flathead Lake in Montana. The growing season varies widely and ranges from about 180 days at Spokane to only 80 to 120 days in the Deer Lodge Valley of Montana.

The primary areas of irrigated cropland in Montana are along the Flathead River south of Flathead Lake, along the Clark Fork east and west of Missoula and the Bitterroot Valley south of Missoula. The principal irrigated crop in Montana and Idaho is hay, approximately one-half of which is alfalfa. Irrigated small grains consist mostly of barley and oats with a relatively small acreage of fruit.

Another relatively large area is in the Spokane Valley. In addition, many scattered tracts exist along the numerous smaller tributary streams. The principal crops are seeds, tree fruits, vegetables, and nursery and greenhouse products. Grass seed (about 50,000 acres) is increasing as a cash crop and is rapidly developing into a major agricultural industry. The most popular grasses are bluegrasses, fescues, and wheatgrasses.

There are nearly 2,000 acres of orchards comprised of sweet and sour cherries, apples, grapes, pears, plums and prunes, and some others. On approximately 2,000 acres a wide variety of vegetables are grown for fresh and processor markets of the Spokane urban area. The variety of vegetables will vary but commonly include potatoes, sweet corn, green peas, asparagus, cabbage, carrots, cucumbers, onions, beans, and lettuce.

Nurseries and greenhouses produce a variety of flowers, bulbs, shrubs, trees, vegetable plants, mushrooms, and other specialties.

Water Conservation

Subregion 1 has an abundant supply of water, however, seasonal water shortages are common. Irrigation is an essential segment of the agricultural economy and is the major consumer of the water resource. Cropping adjustments and patterns which meet water-short years are a common practice. These seasonal adjustments are made possible by snow survey and streamflow forecast data.

Most irrigated land is served by individual or small cooperative systems governed by ditch companies or districts. The

Spokane Valley has approximately 12,000 acres that are served by a pressure system. The system is supplied from approximately 30 wells and 12 water towers. The largest single irrigation system is the Flathead project in Montana, administered by the Bureau of Indian Affairs. Tables 59 and 60 summarize practices, water source, application methods, and amount of irrigation.

Table 59 - Water Conservation Practices Applied on Cropland, Subregion 1, 1966

Practice	Units	Montana	Idaho	Wash.	Subregion
Water Control Facilities	No.	759	81	87	927
Water Storage Facilities	No.	605	509	363	1,477
Irrigation System, Surface & Subsurface	No.	802	2	9	813
Irrigation System, Sprinkler	No.	1,538	261	821	2,620
Irrigation Water Conveyance Facilities	Miles	3,161	11	47	3,219
Land Shaping	Acres	4,065	875	460	5,400
Irrigation Water Management	Acres	81,527	6,661	10,941	99,129

Source: Soil Conservation Service Data.

The primary problems associated with irrigation in this subregion are ditch seepage, poor drainage, steep or irregular topography, and the length of conveyance systems. Water use efficiencies are low, particularly on the smaller tracts along the tributary stream system at the higher elevations. The reuse of return flows is possible in the larger areas. Individual and group sprinkler systems are being installed at an accelerating rate and will achieve considerable improvement in water use efficiencies.

In several areas, the early practice of constructing a ditch for each water user can be replaced by larger concrete-lined canals, reducing water losses and length of ditches. The present emphasis on ditch and canal lining has accomplished many needed consolidations.

Table 60 - Water Availability and Irrigation Methods for Cropland, Subregion 1, 1966

Item	Montana	Idaho	Washington	Subregion
	1000 acres			
Water Source				
Streamflow	293.0	9.9	7.1	310.0
Groundwater	14.7	10.0	16.6	41.3
Reservoir Storage	109.4	3.6	.3	113.3
Total	417.1	23.5	24.0	464.6
Area with Adequate Supply	229.1	23.5	22.4	275.0
Area with Inadequate Supply	188.0	0	1.6	189.6
Method of Application				
Sprinkler	92.5	23.0	22.5	138.0
Flooding	324.6	.5	1.5	326.6

Source: Soil Conservation Service, C-NPRBS Data.

Drainage

Approximately 168,000 acres of cropland have a wetness problem, mostly associated with irrigation, through improper irrigation water management, canal seepage, and inadequate outlets (table 61).

Table 61 - Cropland Areas with a Wetness Problem Subregion 1, 1966

Capability Class	Montana	Idaho	Washington	Total
	1000 Acres			
II	26	28	--	54
III	13	--	25	38
IV	44	18	14	76
Total	83	46	39	168

Source: Soil Conservation Service, C-NPRBS Data.

Many of the poorly drained areas in Idaho are closely associated with flooding. Low lying cropland along the Kootenai, Coeur d'Alene, St. Joe, and along some tributaries of the Spokane River are wet and need drainage to improve agricultural production.

There are also many scattered wet spots on higher land. Wet areas are generally used for hay and pasture. In many cases native grass species are being maintained in these areas.

Wet areas have been drained by systems of open ditches or tile and have resulted in additional cropland yields. The use of tile drain systems is increasing. Open drainage ditches in narrow valleys have created other problems which reduce the size of fields for crop production. The drainage measures applied to cropland through 1966 are shown in table 62.

Table 62 - Drainage Practices Applied to Cropland
Subregion 1, 1966

Practice	Units	Montana	Idaho	Washington	Total
Drainage Conduits and Ditches	Miles	618	143	222	983
Drainage Structures	No.	93	15	1	109

Source: Soil Conservation Service Data.

Erosion and Sedimentation

Erosion is currently a problem on about 221,900 acres, or 14 percent of the cropland. Snowmelt, summer storms, wind action, and inefficient irrigation water management are the principal causes.

Sediment from cropland gives an indication of erosion problems. About 1,500 acre-feet of sediment erodes from cropland annually (table 57). This accounts for 40 percent of the total sediment yield, although cropland is only 7 percent of the total land area.

Nearly all cropland has an erosion potential (table 63). However, land measures combined with cropping patterns have held erosion to a relatively small percentage of the potential. These practices are shown in table 64.

Table 63 - Cropland Areas with an Erosion Potential
by Capability Class, Subregion 1, 1966

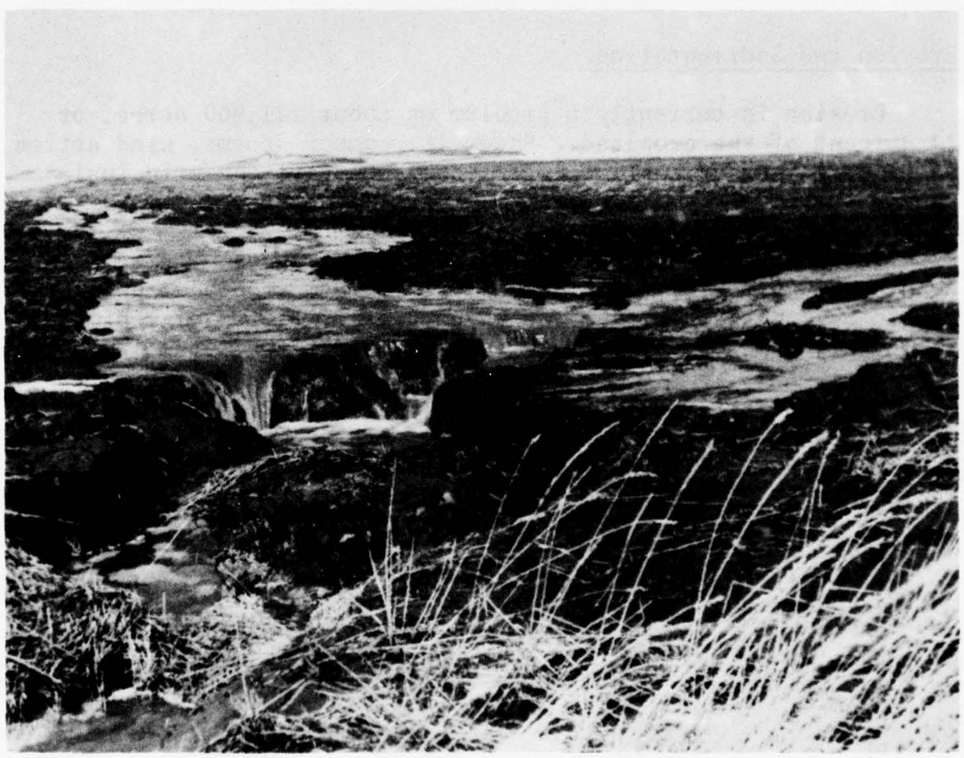
Capability Class	Montana	Idaho	Washington	Total
	1000 Acres			
II	53	--	21	74
III	13	73	169	255
IV	674	78	211	963
Total	740	151	401	1,292

Source: Soil Conservation Service, C-NPRBS Data.

Table 64 - Erosion Control Practices Applied on Cropland, Subregion 1, 1966

Practice	Unit	Montana	Idaho	Wash.	Total
Grade Stabilization Structures	No.	82	10	48	140
Diversions and Terraces	Miles	33	6	3	42
Ditch Bank Seeding	Miles	64	1	78	143
Field Windbreak	Miles	11	1	Tr.	12
Crop Residue Use	Acres	89,240	192,037	209,375	490,652
Stubble Mulch	Acres	53,898	16	18,336	72,250
Grassed Waterway	Acres	224	1,964	2,454	4,642
Stripcropping	Acres	5,373	4,417	2,146	11,936
Conservation Cropping System	Acres	217,515	174,828	174,118	566,461
Pasture and Hayland Planting	Acres	69,547	31,643	50,682	151,872

Source: Soil Conservation Service Data.



Erosion caused by spring runoff cuts ditches across cultivated fields, causing soil loss, restricted equipment use, and downstream sedimentation. (SCS Mt-5958-2)

A given storm such as the June 1964 floods in the upper reaches of the Flathead River in Montana produces large quantities of sediment, although the annual production is relatively low (estimated to be about 1,500 acre-feet annually). This can be attributed to the large percentage of forested lands and vegetated croplands in the subregion.

Flooding

Over 102,500 acres of cropland are subject to flooding. Most flood damages occur during the snowmelt period and can be very serious when melting of the high mountain snowpacks is accompanied by warm spring rains. Summer thunderstorms can cause localized flooding, but the area is usually quite small.

Streambank erosion destroys valuable land and deposits heavy sediment loads downstream. (SCS P94-4)

Since most flooding occurs during the spring, crop losses are minimized. The cropping pattern is another factor which reduces flood losses. Much of the acreage subject to flooding is located along tributary streams where the primary crops are hay and pasture that provide a protective ground cover. On these fields and in stream and ditch channels, silt and debris deposition by flood waters is the primary damage. Acreages lost due to streambank erosion or channel changes during flood periods contribute to the total flood damage problem.

Irrigation water diversion structures are often damaged by flood waters. Many of the privately owned diversion structures do not have the capacity to withstand large flood flows and, therefore, become isolated by flood-caused channel changes. Other structures such as roads, bridges, culverts, and pumping plants, suffer flood damage. The estimated average annual damages are over $3 million. Table 65 shows the flood prevention measures applied by 1966.

Table 65 - Flood Control Measures Applied on Cropland Areas, Subregion 1, 1966

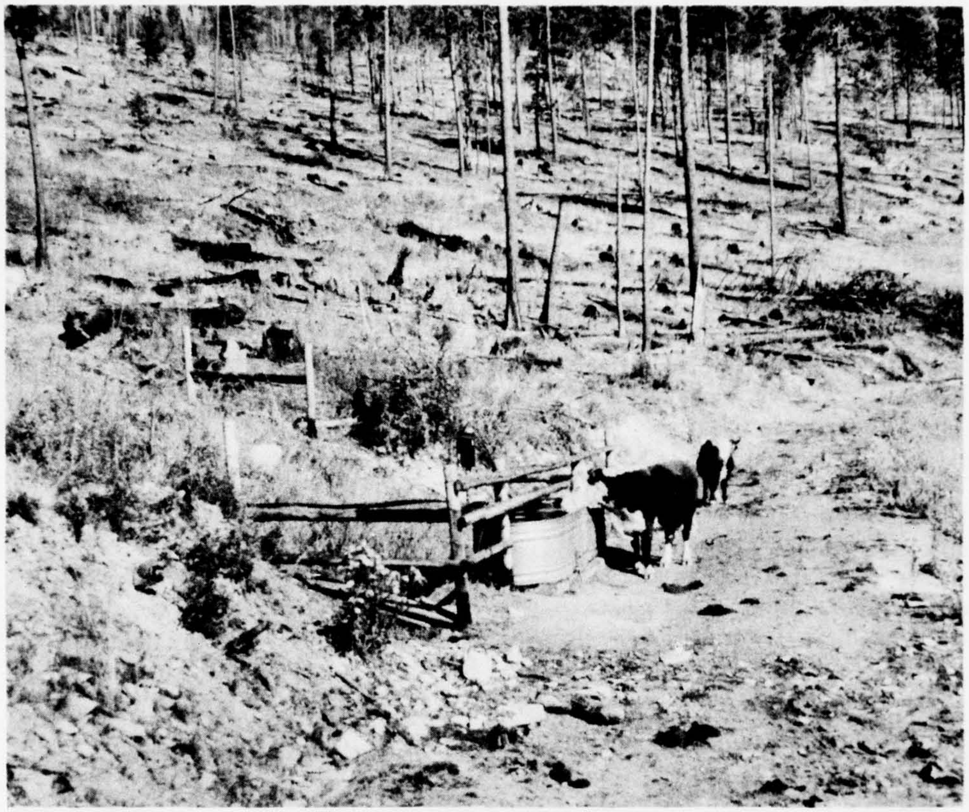
Practice	Unit	Montana	Idaho	Washington	Total
Stream Channel Improvements	Miles	51	50	23	124
Dikes and Levees	Miles	7	1	16	24

Source: Soil Conservation Service Data.

Forest Land

Forests cover 18.2 million acres or 80 percent of the total land area in the subregion. About 72 percent is in public ownership and 28 percent is private. Of this total, 86 percent is commercial and 14 percent is noncommercial. The commercial area supports nearly 116 billion board feet of merchantable timber; 69 percent on public land, 31 percent on private. It supplies raw material for a forest products industry that furnishes 47 percent of the subregion's manufacturing employment. In 1964, 1.9 million board feet were harvested here.

The noncommercial forest land generally lies in the subalpine and dryland fringe between the commercial forest and adjacent barren and grasslands. The subalpine areas provide summer range for wildlife and a limited number of livestock. The lower dry fringes supply key winter range for big game, as well as summer range essential to the continued operation of the livestock industry.



Livestock water development in a seed tree selection timber harvest area. (Forest Service)

In Subregion 1, 94 percent or 29.6 million acre-feet of the runoff originates in the forests. These watersheds provide domestic water for 44 percent of the urban population and over 1.5 million acre-feet for irrigation purposes.

The forest lands are generally in good condition with extremely low sediment yields. Average sediment production is about 1,366 acre-feet per year, or 37 percent of the total sediment from the subregion. (table 66)

Almost 84 percent of the forest land is in the very low sediment yield category, resulting primarily from natural causes. Emphasis has been placed on practices to maintain these conditions. The remaining 16 percent is distributed over the more critical areas where land use activities have added to the problem. It is on these critical areas that watershed rehabilitation work is required and presently being accomplished.

Table 66 - Present Sediment Yield, Forest Land, Subregion 1

Sediment Yield Category	Acres (1,000)	Percent	Annual Sediment Yield Acre-feet Per Square Mile	Total Acre-feet	Percent
Very Low	15,276.9	84	0.02 - 0.1	477	35
Low	1,849.6	10	0.1 - 0.2	289	21
Medium	599.7	3	0.2 - 0.5	187	14
High	510.1	3	0.5 - 1.5	399	29
Very High	5.8	-	1.5 - 4.0	14	1
Total	18,242.1	100		1,366	100

Source: Derived from figures 7 and 9.

Watershed Protection

Timber harvest consists of both selective logging and block cutting. Logs are yarded by tractors or mobile cranes, depending on the terrain. Tractor trails and temporary roads, particularly on Federal lands, are cross-drained and seeded, and debris is removed from live streams and major draws.

Clearcut on Coeur d'Alene National Forest in northern Idaho. (Forest Service)

Most roads have permanent drainage structures, and some heavily used roads are gravel surfaced. On public forests, road locations and standards are designed to minimize soil movement and give maximum opportunity for water dispersion. Many exposed cutbank and fill slopes are now seeded to grass and mulched to reduce erosion. Otherwise, this sediment could wash away or find its way into water courses. Road maintenance during and after log hauling protects the road and drainage structures as well as the soil and water resources.

Where the commercial forest areas receive livestock use, seeding, fencing, and water developments are used to control distribution. Water developments such as the one pictured, are used to disperse the livestock over wider areas. This results in better utilization of the pinegrass and prevents deterioration by over-use in concentrated areas.

Reforestation measures include seeding and planting, generally preceded by burning or scarification. A summary of the annual timber harvest activities and associated practices are shown on table 67.

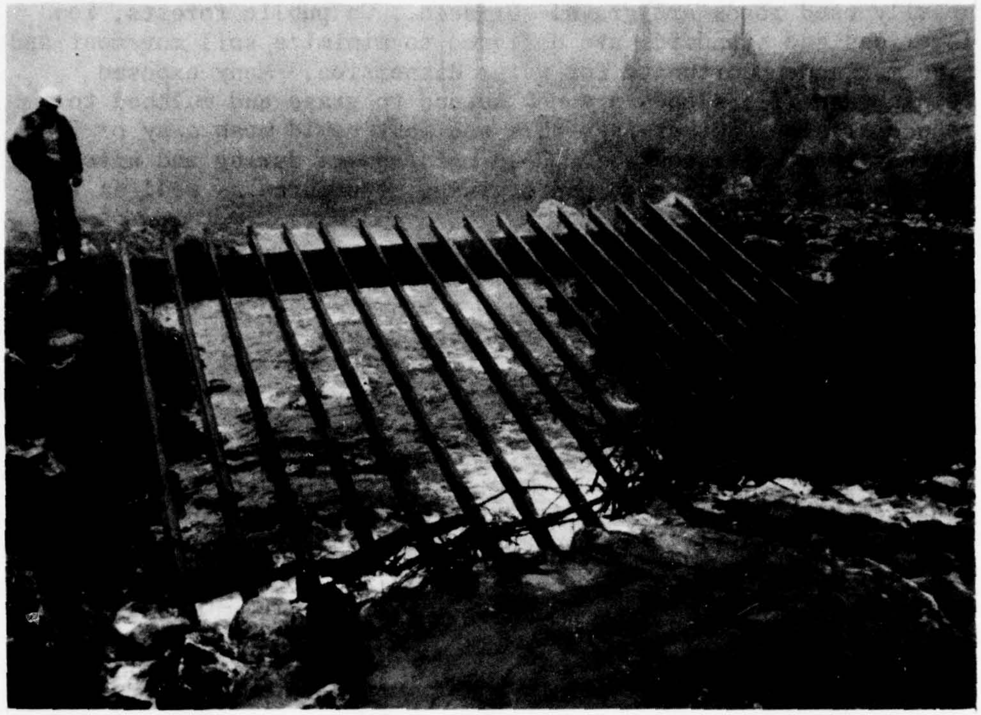
Table 67 - Average Annual Timber Harvest Activity, Subregion 1

	Unit	Public	Private	Total
Harvest Area	Acres	107,000	65,000	172,500
Area Reforested 1/	Acres	85,000	20,000	105,000
Slash Disposal Area	Acres	53,000	30,000	83,000
Disturbed Area Treated 2/	Acres	5,300	--	5,300
Harvest Road Required	Miles	430	260	690
Harvest Road Treated 3/	Miles	335	10	345

1/ Includes planting, seeding and site preparation. Balance adequately stocked or requires no regeneration work.
2/ Includes seeding, mulching, debris removal and cross-draining skid roads and logging areas.
3/ Cut and fill stabilization only.

Watershed Rehabilitation

About 16 percent of the forest land has erosion problems that produce 65 percent of the sediment load from forest areas. These are in the higher yield categories on table 74. Most of this sediment results from water movement through road ditches, down abandoned roads, across areas logged or overgrazed years ago, and



To prevent debris dams and subsequent washouts, a steel rail trash rack is used to catch floating material from the Sundance burn. (Forest Service)

from both abandoned and active mining operations. Past watershed protection measures were either inadequate or lacking altogether. These watersheds in public ownership are now being rehabilitated as rapidly as funds permit. Sheet erosion control on the public forests amounts to about 1,600 acres annually. Nearly 100 miles of existing and abandoned roads and trails and 115 miles of streams are treated each year. This work is shown on table 68.

Not included in the average accomplishment figures listed in table 76 are those areas rehabilitated on a project basis following forest fires or current timber harvest areas. For example, following the 1967 conflagration in north Idaho, some 31,000 acres of burned forest land were seeded to grasses. In addition, stream channels were cleared, bridges rebuilt, new and larger culverts installed, and trashracks constructed. This treatment included all ownerships and was accomplished through cooperative efforts of private, state, and Federal personnel.

Table 68 - Average Annual Accomplishment, Watershed Rehabilitation Practices on Public Forest Land, Subregion 1

Practice	Unit	National Forest[1/]	B.L.M.	Indian Lands	State Lands
Sheet Erosion Control	Acre	130	50	1,500	-
Gully Stabilization	Mile	10	-	-	-
Stream Clearance & Stabilization	Mile	110	1	4	-
Existing Road & Trail Rehabilitation[2/]	Mile	20	25	70	-

1/ Average of period 1964-66.
2/ Includes abandoned roads.
Source: Data furnished by agency as listed.

Water Yield Improvement

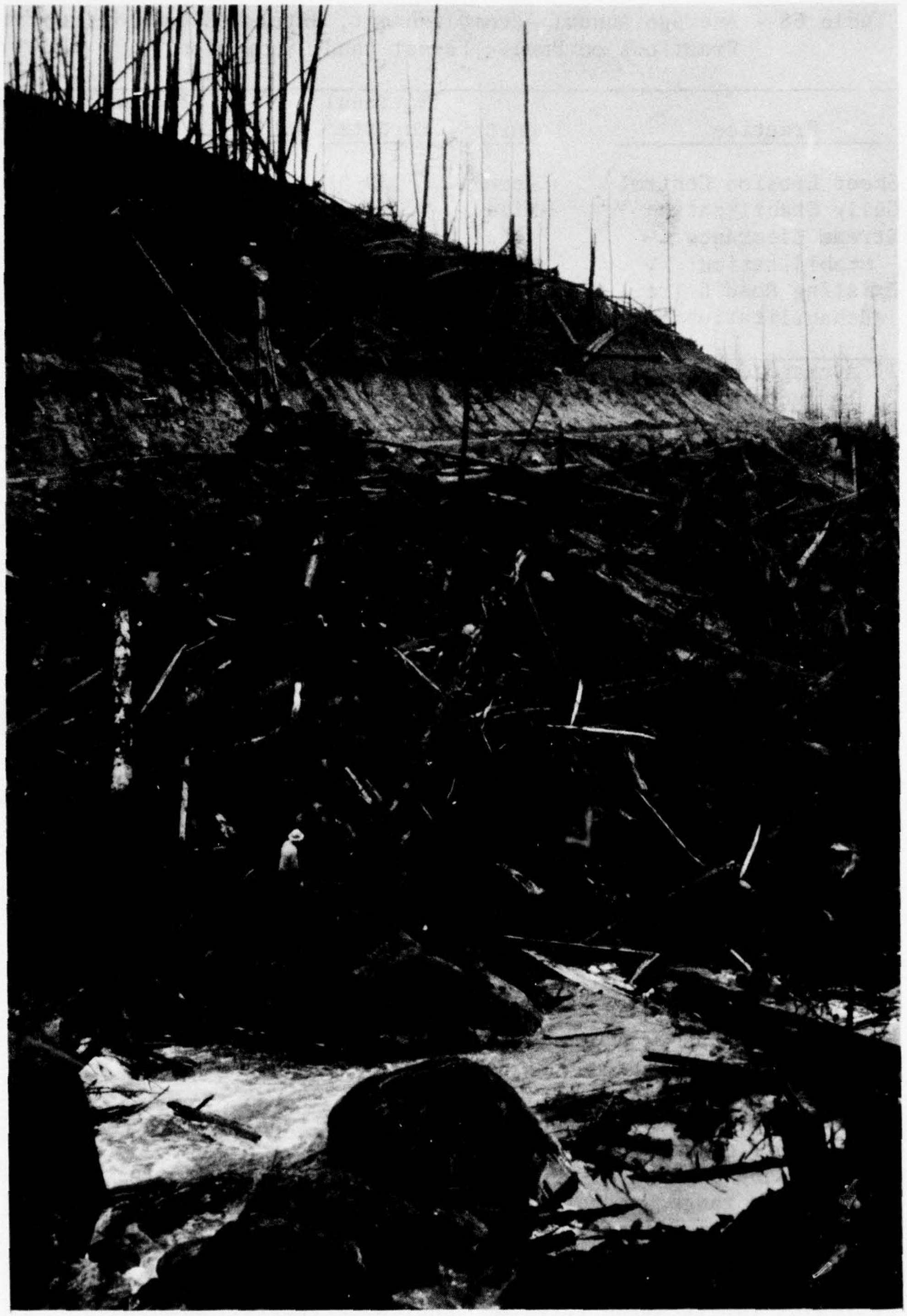
Management programs directed toward water yield improvement in this subregion are nonexistant at this time. Activities such as logging and thinning can increase water yields, but in the past such increases were not the primary objective involved.

Rangeland

Subregion 1 has 1.7 million acres of rangeland, 7 percent of the land area (table 57). About 1.1 million acres or 64 percent are privately owned (Appendix IV, Land and Mineral Resources).

Present rangeland condition and grazing capacity are shown in table 69. Grass and forbs comprise the predominant cover on 71 percent of the range, brush and shrubs on 20 percent, and sage-brush on 9 percent. Private rangeland is in considerably better condition than the public range, accounting for 64 percent of the total range acreage and 77 percent of the total grazing capacity. The estimated average grazing capacity of the private range is 5 acres per AUM compared to 10 acres per AUM on the public range.

Rangelands, although in better condition than those in many other parts of the region, have been damaged by overgrazing and fire, and by plowing of areas unsuited for continuous cropping. Much of the range has deteriorated considerably both in grazing capacity and in its effectiveness for watershed protection. With the loss of protective vegetative cover, soil conditions conducive to maximum yields of usable water have deteriorated, causing decreased infiltration rates and increased runoff. Excessive grazing use has been reduced on about 662,000 acres (39 percent of all rangeland). Yet, at the present time, only 26 percent is in



A mobile yarder removes logs and other heavy debris left by the Sundance fire from stream channels. (Forest Service)

Table 69 - Rangeland Condition and Capacity, Subregion 1, 1966

Range Type and Condition	Ownership: Public Acres (1,000)	Public AUMs (1,000)	Private Acres (1,000)	Private AUMs (1,000)	Total Acres (1,000)	Total AUMs (1,000)
Grassland						
Good	2.2	.7	315.5	98.6	317.7	99.3
Fair	35.1	5.0	414.2	59.2	449.3	64.2
Poor	355.8	28.5	20.6	1.6	376.4	30.1
Seeded Range 1/	49.6	16.5	21.3	7.1	70.9	23.6
Total	442.7	50.7	771.6	166.5	1,214.3	217.2
Sagebrush						
Good	.1	.0	1.4	.3	1.5	.3
Fair	10.0	1.1	51.2	5.7	61.2	6.8
Poor	52.7	3.0	33.9	1.9	86.6	4.9
Total	62.8	4.1	86.5	7.9	149.3	12.0
Other Brush						
Good	1.7	.4	48.5	12.1	50.2	12.5
Fair	15.7	2.0	144.9	18.1	160.6	20.1
Poor	83.3	2.8	40.4	1.4	123.7	4.2
Total	100.7	5.2	233.8	31.6	334.5	36.8
Total						
Good 2/	53.6	17.6	386.7	118.1	440.3	135.7
Fair	60.8	8.1	610.3	83.0	671.1	91.1
Poor	491.8	34.3	94.9	4.9	586.7	39.2
Grand Total	606.2	60.0	1,091.9	206.0	1,698.1	266.0
Percent Distribution	35.7	22.6	64.3	77.4	100.0	100.0
Average AC/AUM	10.1		5.3		6.4	

1/ Seeded range acreage was combined with good condition grassland in Appendix IV.
2/ Includes seeded range.
Source: Appendix IV, Subregion 1. Range production has been estimated for the C-NP Study from representative situations observed and recorded in on-site surveys. Estimates are based on perennial vegetation and proper utilization.

good range condition, and 35 percent remains in poor condition with deficient vegetative cover and considerable accelerated erosion. On some range areas at lower elevations, the loss of good forage plants has resulted in the removal of top soil through sheet and gully erosion. Repeated wildfires and sheet erosion on some grassland areas have caused site deterioration, and natural recovery may take many years. Grazing by livestock is the principal cause of erosion in the lower foothill areas of the Little Bitterroot and Jocko River valleys south and west of Flathead Lake. Overgrazing has also caused accelerated erosion in the Upper Clark Fork, Bitterroot, and Blackfoot Valleys.

While rangelands are in the lowest annual water yield areas, as shown in figures 7 and 8, they still produce 497 acre-feet of sediment annually (table 70), or about 14 percent of the total subregional sediment yield. About 338 acre-feet or 68 percent of the sediment yield comes from 556,000 acres (33 percent of the total range acreage) in the "High" and "Medium" sediment yield categories. Rangelands with highest sediment yields are located in the areas mentioned above and in smaller areas interspersed with cropland around Spokane.

Table 70 - Sediment Yield from Rangeland, Subregion 1, 1966

Sediment Yield 1/ Categories	Grassland	Sagebrush & Shrubs	Total	Percent
		Rangeland Acreage (1,000 Acres)		
Very Low	410.4	358.4	768.8	45
Low	329.0	44.8	373.8	22
Medium	474.9	47.3	522.2	31
High	--	33.3	33.3	2
Very High	--	--	--	--
Total	1,214.3	483.8	1,698.1	100
		Annual Sediment Yield (Acre-Feet)		
Very Low	38	34	72	14
Low	77	10	87	18
Medium	260	26	286	57
High	--	52	52	11
Very High	--	--	--	--
Total	375	122	497	100

1/ Very Low through Very High categories represent generalized range areas on which annual sediment yield per square mile averages .06, .15, .35, 1.00, and 2.75 acre-feet, respectively.
Source: Derived from figures 4 and 6.

Measures and Practices for Watershed Protection

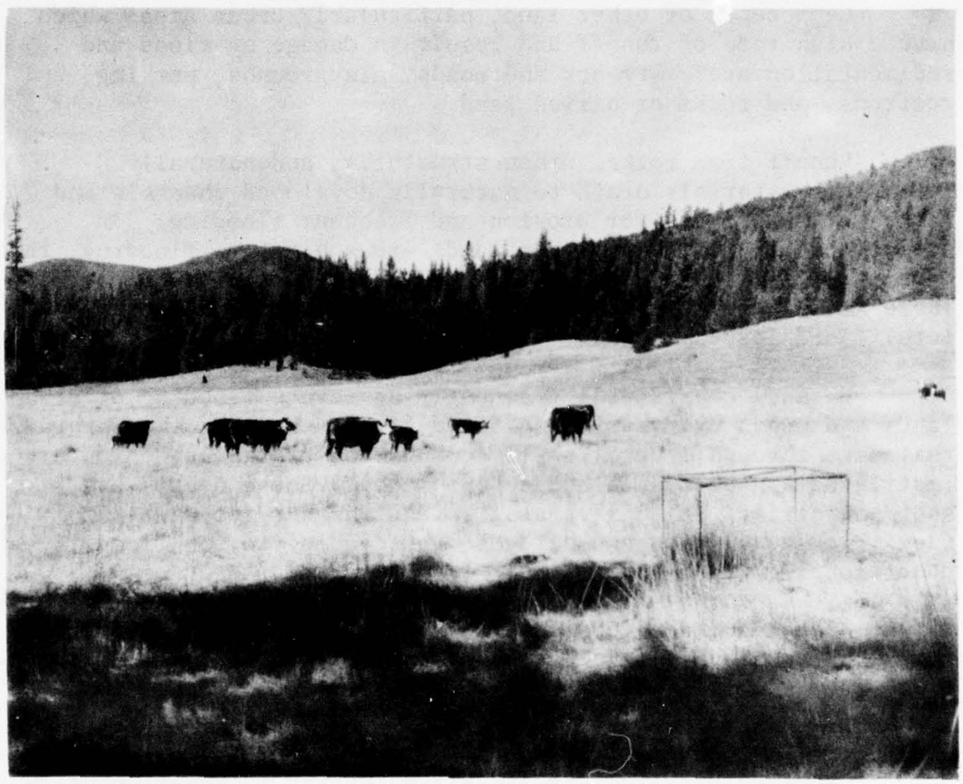
Measures and practices accomplished through 1965 are shown on table 71. Cover improvement and soil stabilization practices have been applied on a combined total of about 300,000 acres. An estimated 50 percent of the benefit of range seeding was for erosion and water quality control, 10 percent for water conservation, and 40 percent for forage production. An estimated 2,600 acres (approximately 130 miles) along streams or above reservoirs have received stabilization treatment to prevent erosion and reduce excessive flow.

Significant progress has been made in adjusting livestock grazing use to the grazing capacity of the range and achieving better livestock distribution. Throughout the subregion, but particularly on more mountainous or hilly areas, attainment of uniform grazing use distribution is difficult. Grazing use has been reduced on an estimated 662,000 acres of poor condition watershed areas by either excluding livestock or by deferred and rotation grazing. Additional water development has been necessary to insure more uniform utilization by livestock and game.

Table 71 - Rangeland Measures and Practices for Watershed Protection and Other Management Purposes
Subregion 1, 1966

Measures & Practices	Units	Land Ownership Public 2/	Private	Total	Watershed Purposes 1/ (1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	49,600	21,300	70,900	-	x	x	-
Brush Control	Acres	21,600	28,700	50,300	-	x	x	-
Weed Control	Acres	58,800	106,000	164,800	-	x	x	-
Fertilizing	Acres	600	1,000	1,600	-	-	x	-
Deep Tillage	Acres	100	200	300	-	x	-	-
Stream & Bank Stabilization	Acres	900	1,700	2,600	-	x	x	x
Waterspreading	Acres	300	500	800	-	x	x	-
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	1,600	2,900	4,500	-	x	x	x
Reducing Excessive Grazing Use	Acres	154,800	507,500	662,300	-	x	x	-
Livestock & Game Water Facilities	Number	200	500	700	-	x	x	-
Road Stabilization	Miles	400	NA 3/	NA 3/	-	-	x	-
Pollution Abatement	Miles	15	20	35	-	-	x	-
Water Control Structures								
Ponds & Small Reservoirs	Number	35	65	100	-	x	x	x
	Acre Ft.	32	58	90	-	x	x	x
Check Dams (Gully Plugs)	Number	15	20	35	x	x	x	-
	Cu. Yds.	130	230	360	x	x	x	-
Diversions	Number	20	220	240	x	x	x	-
	Cu. Yds.	100	600	700	x	x	x	-

1/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4-Flood & Debris Control.
2/ Includes Federal, State, County, and Municipal Ownership.
3/ Not available.
Source: Data collected from land management agencies specifically for the C-NP Study.



This good condition grass area is located in the Kaniksu National Forest. (Forest Service)

Other Land

Other land amounts to over 1,327,000 acres, which is almost 6 percent of the total land area. The acreage of other land categories is shown in table 72.

Table 72 - Other Land Areas, Subregion 1

	Montana	Idaho	Wash.	Total	Percent
	------------1000 Acres------------				
Small Water	51.8	4.1	4.7	60.6	4.6
Roads & Railroads	92.4	24.5	26.3	143.2	10.8
Farmsteads, Urban, Industrial & Misc.	117.7	14.7	79.7	212.1	16.0
Barren land	737.9	154.1	19.2	911.2	68.6
Total	999.8	197.4	129.9	1,327.1	100.0

Source: Appendix IV, Land and Mineral Resources.

Components of other land, particularly urban areas which have a high rate of runoff and result in damage by flood and sedimentation are: Streets and roads, playgrounds, parking, rooftops, and rocks or barren land.

Runoff from rocks, urban structures, and naturally impervious materials drain to naturally developed channels and increase the chances for erosion and frequent flooding. An estimated 6,200 acres of urban lands are subject to flooding, the magnitude of which is increased by building on the flood plains. These areas represent a substantial portion of the subregion's total flood losses.

Channel debris will frequently aggravate flooding of urban lands and roads by restricting flood flows. Many of the waterways that pass through several small communities of the subregion are restricted by vegetation and developments. Loose debris and sediment collect on this vegetation and further restrict water flow through culverts and bridges, thus adding to the flood condition.

An estimated 15,000 acres of other land, principally in urban and suburban areas, have been irrigated. Irrigation management practices for these areas are similar to those described in the cropland section.

Suburban developments are often located on soils unsuited for foundation footing and septic tank and basement drainage. The

subregion is noted for its numerous lakeside communities. Septic tanks generally provide sewage disposal, and shallow wells are commonly used for water supply. Sewage is entering these lakes and wells, reducing their esthetic and functional values.

Other land adds materially to water quality problems. Disposal of waste from agricultural processing plants and private residences is inadequately provided for in several communities. The urban sewage system may dump untreated waste into streams. Private lake properties frequently discharge their wastes into lakes. Certain chemicals which adversely affect the biological activity of lagoon systems are also discharged into the sewage system. A few communities have septic tanks that overflow during wet seasons and discharge effluent into streams.

Floodwaters flowing through mobile home village cause damage to mobile homes and contents, restrict travel, and create health problems. (SCS Mt-P488-16)

FUTURE NEEDS

Population is projected to increase from 564,000 in 1960 to 1.1 million by 2020, an increase of 98 percent, with an accompanying demand for more urban lands and recreation land use areas. Cropland is expected to increase 278,000 acres, other land uses about 317,000 acres, and reservoir areas 224,000 acres. Most of these increases will occur on present rangeland. Rangeland acreage is expected to decrease from 1.7 million acres in 1966 to 1.2 million acres by 2020, a reduction of 27 percent or 461,000 acres (table 73).

Table 73 - Projected Changes in Cover and Land Use, Subregion 1

Item	1966	1980	2000	2020
		(1,000 acres)		
Cropland	1,552	1,737	1,739	1,930
Forest Land	18,242	18,118	17,974	17,784
Rangeland	1,698	1,439	1,411	1,237
Other Land	1,327	1,414	1,530	1,644
Total	22,819	22,708	22,654	22,595

Source: Columbia-North Pacific Projections.

Cropland

While the total population is expected to double by 2020, the farm population will decrease by approximately one-half (from 36,300 to 15,500). This will require increased production by fewer farm workers.

Necessary increased agricultural production will be confined mostly to irrigated cropland areas. The irrigated areas are projected to expand by approximately 590,000 acres (table 74).

Table 74 - Projected Trends in Dry and Irrigated Cropland, Subregion 1

Cropland	1966	1980	2000	2020
		(1,000 acres)		
Dry Farmed	1,087	904	814	650
Irrigated1/	465	833	925	1,280
Total	1,552	1,737	1,739	1,930

1/ Approximately 97 percent of the total area projections shown in Appendix IX, Irrigation.
Source: Soil Conservation Service, C-NPRBS Data.

Water Conservation

Changing land use, crops planted, and public demands will require modification in application methods to achieve an adequate supply of quality water. Future irrigation expansion will be by sprinkler system because of the rolling terrain and reduced labor requirements. In addition, some cropland now being irrigated by the flood method will convert to sprinklers. Changes in irrigation methods to meet the demand for better water management and improved efficiencies are shown in table 75.

Table 75 - Projected Cumulative Trend in the Method of Irrigation on Cropland, Subregion 1

Item	1966	1980	2000	2020
		(1,000 acres)		
Sprinkler Systems	139	539	672	1,073
Flood Systems	326	294	253	207
Total	465	833	925	1,280

Source: Soil Conservation Service, C-NPRBS Data.

While water is normally plentiful, there are many localized areas that experience seasonal shortages requiring a dependable water supply. It is predicted that water supplies will be developed for most of the water-short areas. Nearly all water-short areas are located in the Montana portion of the subregion (table 60).

Sprinklers can improve efficiency, conserve water, and eliminate the necessity of land leveling. (SCS Mt-P433-6)

The increase in irrigated area and the development of supplemental water supplies for water-short areas will increase the demand for agricultural water despite improving the efficiency of its use about 25 percent by 2020.

Drainage

Production on approximately 168,000 acres of cropland is presently limited by wetness. Drainage practices have been applied on 41,000 acres. By 2020, with an increased irrigated cropland area, 249,000 acres will be subject to drainage problems. In order to obtain required cropland production, drainage practices must be applied on some 173,000 acres by 2020. The rate at which drainage work should be completed is based on increased food and fiber needs and shown on table 76.

Table 76 - Cumulative Cropland Areas Needing Drainage, Subregion 1

Item	1966	1980	2000	2020
		(1,000 acres)		
Wet Areas	168	182	215	249
Projected Accomplishments	41	74	126	173
Remaining	127	108	89	76

Source: Soil Conservation Service, C-NPRBS Data.

Erosion and Sedimentation

Approximately 221,900 acres of cropland presently have erosion problems with soil loss and accompanying flood and sediment damage. Most cropland is potentially erodible and erosion problems could become more severe with increased production demands and more irrigated land. A combination of vegetative and structural measures is needed to reduce these problems to an acceptable level. The increase in the erosion problem and the rate at which these areas need treatment are shown in table 77.

Table 77 - Cumulative Cropland Areas Needing Erosion Control, Subregion 1

Item	1966	1980	2000	2020
		(1,000 acres)		
Erosion Potential	1,292	1,386	1,481	1,575
Projected Accomplishments	1,070	1,225	1,380	1,533
Remaining	222	161	101	42

Source: Soil Conservation Service, C-NPRBS Data.

Flooding

At the present time about 102,500 acres of cropland are subject to frequent flooding. The future needs for flood protection can be expected to increase. Cropland flooding must be reduced to permit more intensive use. Some areas now in rangeland that will be shifted to cropland will need flood protection. A more serious problem will be associated with protection of developments accompanying the increase in irrigated acreage.

Forest Land

The forest industries in Subregion 1 will require an estimated 548 million cubic feet of wood supply per year by the year 2020. This raw material will be produced on the 15.3 million acres of commercial forest land which is predicted to remain in timber production throughout this period. This amounts to 35.8 cubic feet per acre per year. Since the present industrial consumptive rate is 28.2 cubic feet per acre of commercial forest land, timber yield improvements will be mandatory. In this subregion, restocking, thinning, fertilization, and tree release are the principal management practices that are needed.

Potential sediment yield and erosion hazard on the forest lands are depicted on table 78 and figure 10. Although the subregion is generally all in the low yield categories, the potential is still more than double that of present levels. Since downstream water quality can be reduced by any degree of erosion, it is important that protective practices be encouraged on all these lands.

Table 78 - Potential Sediment Yield without Protective Measures, Forest Land, Subregion 1

Soil Loss Category	Acres (1,000)	Percent	Acre-feet per Square Mile per year	Total Acre-feet per Year
Low	17,042.1	94	less than 0.2	2,663
Medium	1,200.0	6	0.2 - 1.5	375
High	-	-	more than 1.5	-
Total	18,242.1	100		3,038

Source: Soil Survey Data and Interpretations, Forest Service, Region 1.

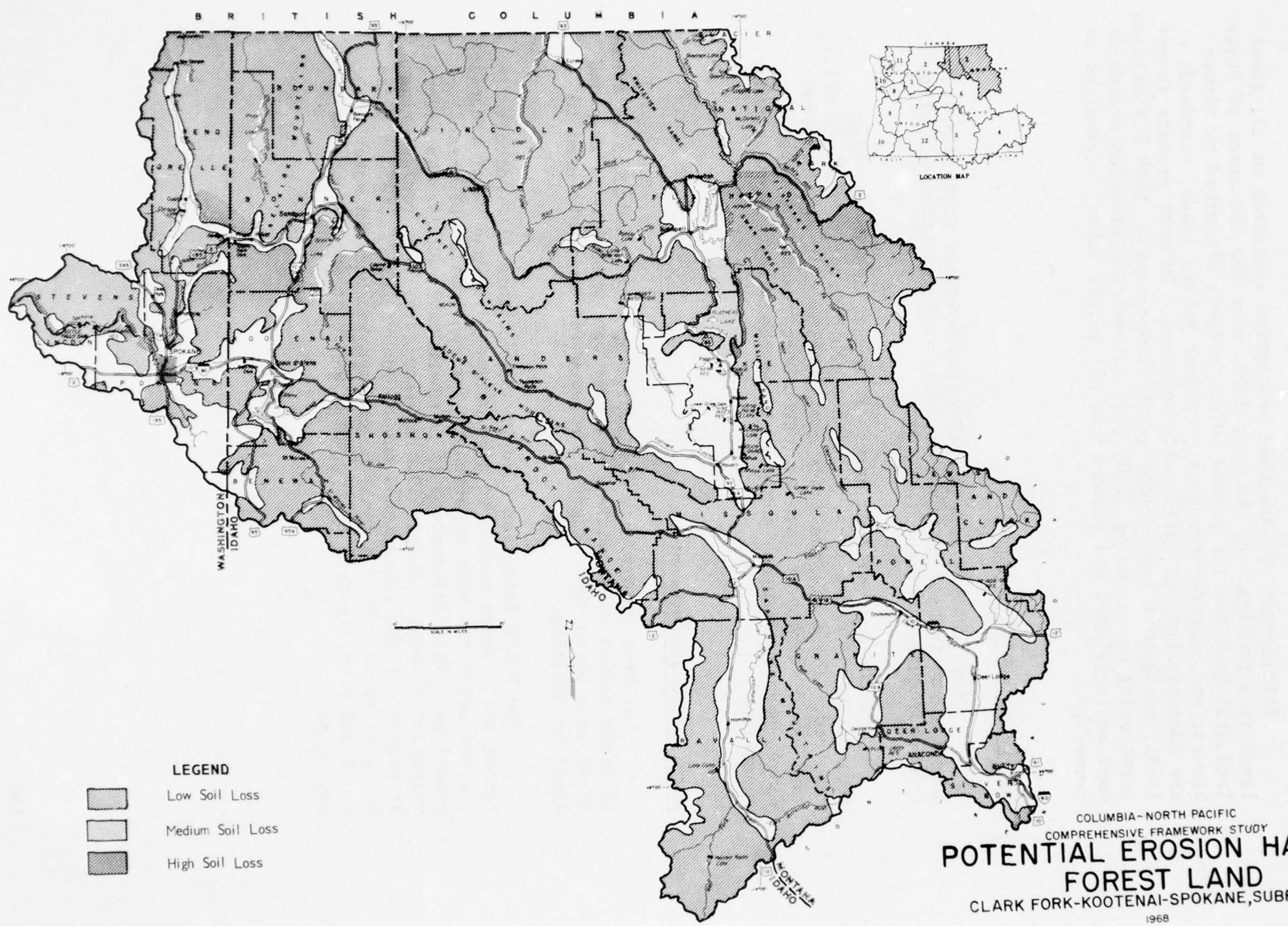
Watershed Protection

The present annual timber harvest and road construction requirements are listed on table 67. Future production goals may accelerate this activity, resulting in increased ground disturbance. These timber harvest areas, miles of road construction, and disturbed ground requiring protection are shown in table 79.

Table 79 - Projected Cumulative Timber Harvest Activity, Forest Land, Subregion 1 1/

	Unit	1980	2000	2020
Timber Harvest Area	Ac.	2,616,000	6,071,000	9,525,000
Road Construction	Mi.	10,500	24,300	38,100
Ground Disturbance 2/	Ac.	235,000	546,000	857,000

1/ Based on the 1965 level of timber requirements.
2/ Includes both harvest area requiring protection and road mileage, converted to acres, requiring cut and fill treatment.



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POTENTIAL EROSION HAZARD FOREST LAND

CLARK FORK-KOOTENAI-SPOKANE, SUBREGION I

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FIGURE 10

Enforcement of watershed protection standards on all these lands is a problem. By the year 2020, over 850,000 acres of forest land will have had the ground cover severely disturbed by timber harvest and road construction. On most public lands, standards are adequate but not uniformally enforced. On most private forest lands, management improvement is still necessary. With 9.5 million acres being harvested by 2020, good watershed protection standards must be legislated and enforced on all forest lands, regardless of ownership.

Watershed Rehabilitation

Future demands for the subregion's water, particularly for domestic and industrial purposes, will require improved quality through reduced sediment loads.

On the half million acres of forest land in the high sediment yield categories, watershed rehabilitation work is still required. These are the lands contributing silt from previous land use disturbances such as logged over tracts, overgrazed range, abandoned roads, damaged stream channels, and old mining operations.

Water Yield Improvement

The best opportunity for improving water yields is in areas of dense forest cover where the canopy can be broken to trap and shade snow or on open ridges where snow fences can be used to localize drifting.

The Water Retention Capacity Map (figure 11) indicates the forest soils where medium to high permeability and water retention factors offer the best opportunity for application of these practices. This information is shown on table 80 for the several retention classes. Nearly 29.6 million acre-feet, representing 94 percent of the subregion's annual runoff, originate on these forested areas. Even a small percentage increase in water yield would add significantly to the total water production of the subregion.

Table 80 - Water Retention Capacity, Forest Soils, Subregion 1

Retention Class	Acres (1,000)	Percent	Acre-feet per Square Mile	Total Acre-feet
Low	--	--	less than 300	--
Medium	16,965.2	93	300 - 1,500	25,183,000
High	1,276.9	7	more than 1,500	8,977,000
Total	18,424.1	100		34,160,000

Source: Soil Survey Data and Interpretations, Forest Service, Region 1.

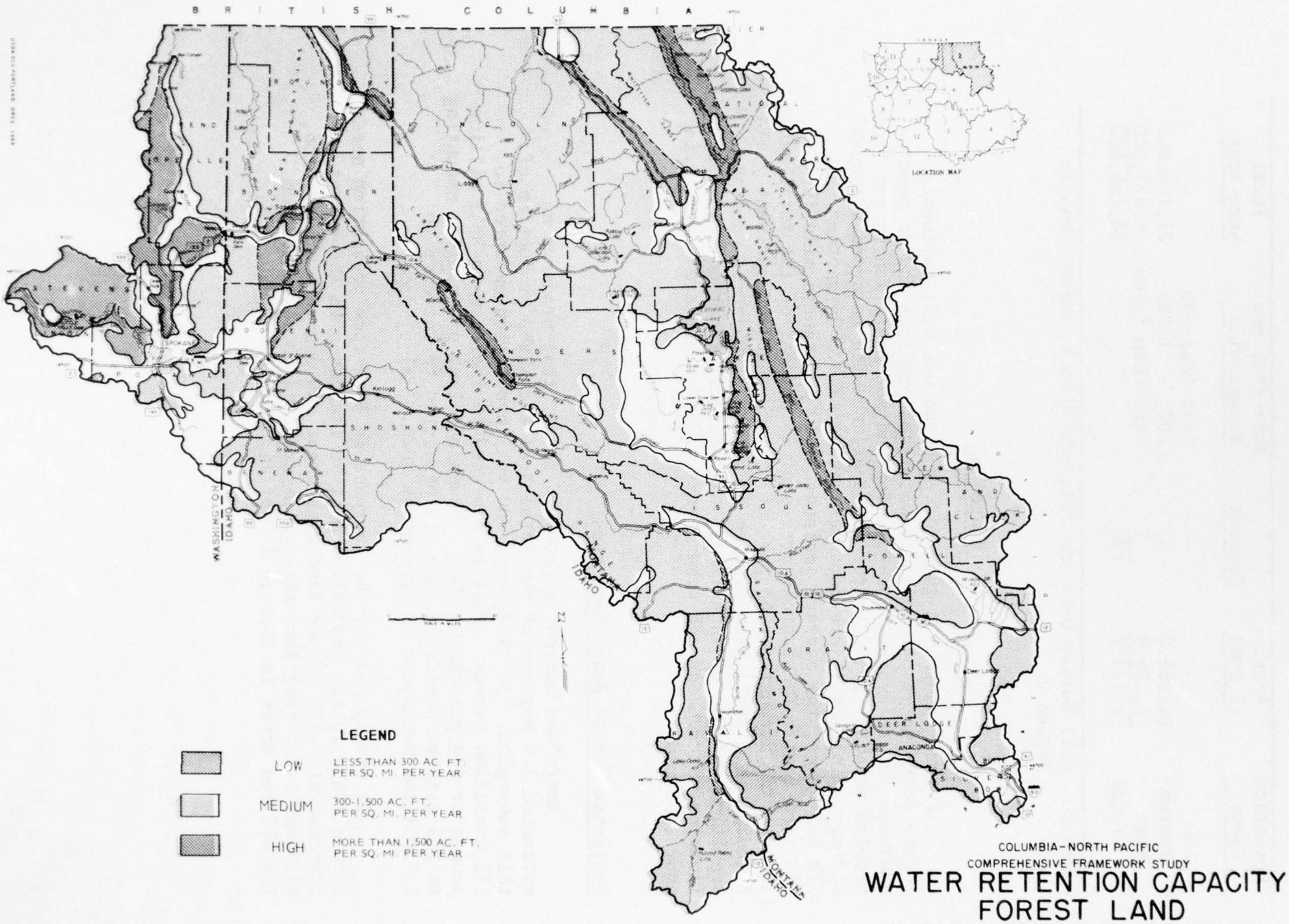
Rangeland

Future changes in land and resource use will influence requirements to resolve present watershed problems and to provide adequate future protection. Erosion and sedimentation is a serious problem an about 33,000 acres of rangeland with an average annual sediment yield of 1 acre-foot per square mile. On another 522,000 acres, the average sediment yield per square mile is .35 acre-foot. These areas represent 33 percent of the total range acreage and account for 68 percent of the rangeland sediment yield. Flooding is a particular problem on about 25,000 acres, and the condition and use of rangelands have a direct effect on downstream flooding of cropland and urban areas. Many range areas remain in poor condition.

Projected Use of Range Resources

Rangeland currently provides forage that produces an estimated 3.9 percent of the total beef and sheep production of this subregion. In 1964, beef and veal production amounted to 131.6 million pounds. This is expected to increase to 307.9 million pounds or 134 percent by 2020. Sheep and lamb production, amounting to 3.3 million pounds in 1964, is projected to increase to 5.7 million pounds or 73 percent by 2020. (3)

To meet a part of the increase in livestock production needs, future range forage production must be increased to the extent commensurate with proper land management and resource utilization, although total rangeland acreage is expected to decrease from 1.7 million acres in 1966 to 1.2 million acres by 2020. (3)



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WATER RETENTION CAPACITY FOREST LAND

CLARK FORK-KOOTENAI-SPOKANE, SUBREGION I

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FIGURE 11

Watershed Needs

An estimated 209,000 acres of rangeland have received land treatment for erosion and sedimentation control with accompanying benefits for flood control and drainage. This includes most of the measures and practices for cover improvement and soil stabilization given in the "Present Status" section, along with road stabilization. Where multiple practices were involved, overlapping acreage was deleted. An additional 339,000 acres will require treatment by 1980, 611,000 acres by 2000, and 758,000 acres by 2020. A number of small water control structures are needed to assure adequate erosion and sediment control.

Protection and management practices had been applied on some 662,000 acres of rangeland by 1966, including reduction or adjustment of livestock grazing use to the grazing capacity of the range, and special fire control practices where required. Other management practices for improved livestock distribution and control included development of livestock and game water facilities and construction of livestock control fences. These protection and management practices should be extended to an additional 222,000 acres by 1980, 443,000 acres by 2000, and 665,000 acres by 2020.

An estimated 35 miles of streams and waterways in rangeland areas will have been improved by stream clearance, channel improvement, or efforts required to improve water quality. An additional 11 miles need attention by 1980, 151 miles by 2000, and 251 miles by 2020.

Some 130 miles of bank stabilization work have been accomplished in rangeland areas by 1966. This includes the stream and bank stabilization acreage reported in the "Present Status" section with conversion to miles on the basis of 20 acres per mile. Future needs include an additional 200 miles of bank stabilization along streams or reservoirs by 1980, 300 miles by 2000, and 405 miles by 2020.

Other Land

Population will increase from 564,000 to 1.1 million by 2020. The land that is needed for urban and industrial purposes, road construction, and other uses is expected to increase from 1,327,100 to 1,644,100 acres by 2020. A strong demand exists for waterfront and view properties, which is strengthened by outside interests.

More efficient water management practices are required in the irrigation of lands in urban and suburban areas and along roadsides, which are projected to increase from 15,000 acres to 40,000 acres by 2020.

Urban areas will require intensified flood protection and sedimentation control. About 6,200 acres of urban land are subject to frequent flooding. From a present development of 212,000 acres, new construction is projected to occupy another 60,000 acres by 2020. Some of this will require additional flood protection. Clearing and grading of these areas can seriously accelerate local sedimentation problems. Timely stabilization is necessary as construction proceeds to insure that no degradation of the subregion's tributary streams results from these activities.

MEANS TO SATISFY NEEDS

Watershed protection measures will diminish peak flows, reduce sediment production associated with runoff, and will contribute to the control and reduction of pollution. The specific means to accomplish needed watershed protection and management are discussed in terms of individual items which are costed in 1969 dollars.

Frequently, the most effective means to satisfy land treatment needs is to apply practices by cooperative efforts of the landowners. Of 213 watersheds in the subregion, 125 have been identified as having a complexity of problems which will require coordinated planning and development efforts. Information contained in table 81 presents watersheds and type of practices by area treated. Suggested progress of development is illustrated on figure 12.

Cropland

Cropland is predicted to increase from 1.5 million acres in 1966 to 1.7 million acres by 2020. This is well within the total area of potential cropland as outlined in table 82. Irrigated land will increase from 465,000 acres to 1,055,000 acres. The increase in dryland to irrigated cropland can primarily be accomplished by shifting from dryland to irrigated cropland, but some will be from forest and range to irrigated croplands.

Table 81 - Practices Required for Cooperative Conservation Development, Subregion 1

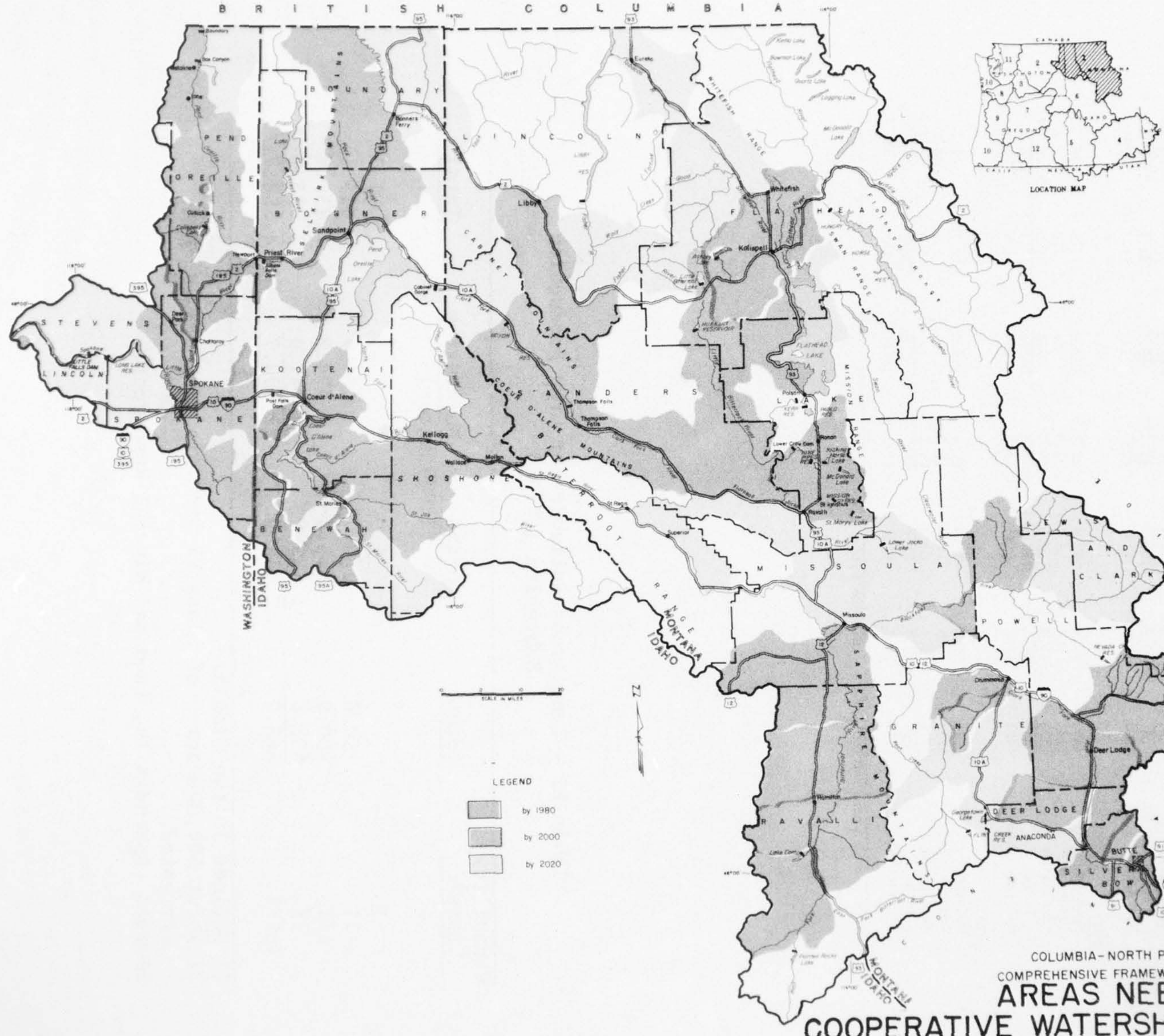
Target Date and State	Watersheds (No.)	Flood Protection	Erosion Control	Drainage	Irrigation New	Irrigation Supplemental	Land Treatment
		(1,000 acres)					
1980							
Montana	(14)	31.2	46.8	14.2	49.0	34.2	57.2
Idaho	(10)	5.4	20.5	5.6	1.3	.5	34.6
Washington	(5)	4.9	34.5	25.3	16.0	-	39.7
Total	29	41.5	101.8	45.1	66.3	34.7	131.5
No. Watersheds	(29)	(28)	(14)	(28)	(12)	(11)	(29)
2000							
Montana	(20)	44.6	82.4	22.4	132.0	113.5	85.8
Idaho	(14)	7.6	26.7	7.9	1.8	2.0	51.9
Washington	(12)	11.8	26.5	60.7	69.0	2.0	28.8
Total	46	64.	135.6	91.0	202.8	117.5	166.5
No. Watersheds	(46)	(43)	(13)	(38)	(17)	(17)	(46)
2020							
Montana	(23)	51.3	36.8	26.5	68.0	19.2	47.7
Idaho	(16)	8.6	14.8	16.3	1.8	4.3	28.8
Washington	(11)	10.8	20.8	55.7	43.0	3.0	33.1
Total	50	70.7	72.4	98.5	112.8	26.5	109.6
No. Watersheds	(50)	(36)	(10)	(39)	(12)	(13)	(48)

Source: Soil Conservation Service, C-NPRBS Projections.

Table 82 - Land Areas Suitable for Crop Production
Subregion 1, 1966

Capability Class1/	Idaho	Montana	Washington	Total
		(1,000 acres)		
I	-	1.0	-	1.0
II	50.0	280.2	84.9	415.1
III	160.0	500.8	474.8	1,135.6
IV	633.0	1,829.0	541.0	3,003.0
Total	843.0	2,611.0	1,100.7	4,554.7 2/

1/ Defined in the Glossary.
2/ About 500,000 acres of Class VI land are also arable when irrigated.
Source: Appendix IV, Land and Mineral Resources.



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COMPREHENSIVE FRAMEWORK STUDY

AREAS NEEDING COOPERATIVE WATERSHED DEVELOPMENT

CLARK FORK-KOOTENAI-SPOKANE, SUBREGION I

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FIGURE 12

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Water Conservation

Increases in irrigated acreage and shifts in water application methods will require intensification of irrigation water management practices. Practices necessary to provide efficient water use are shown in table 83.

Table 83 - Cumulative Projected Practices for Irrigated Cropland, Subregion 1

Practices	Unit	1966	1980	2000	2020
Water Control Facilities	No.	927	1,223	1,515	1,747
Irrigation Water Conveyance	Miles	3,219	3,600	4,190	4,670
Water Storage	No.	1,477	1,510	1,660	1,740
Irrigation Systems					
Surface	No.	6,540	5,350	4,213	3,189
Sprinkler	No.	2,620	3,949	4,649	6,280
Land Shaping	1000 Acs.	5.4	30.0	65.0	110.0
Irrigation Water Management	1000 Acs.	99.1	342.0	570.0	949.0

Source: Soil Conservation Service, C-NPRBS Data.

Fluctuations in flows must be managed to assure water during periods of need. Timely application of land treatment and structural measures can substantially regulate flows and reduce crop damage, erosion, sedimentation, and pollution which are now associated with highly fluctuating flow conditions.

Drainage

Systems to provide needed cropland drainage will shift from open to closed since these offer several advantages. Unlike open ditches, closed drainage systems do not have land requirements or weed and sedimentation problems. In addition, tile drainage systems do not restrict farming operations. Flood protection and irrigation water management are complementary practices on much of the acreage needing drainage. Practices that will be necessary to drain cropland areas at the projected rate are shown in table 84.

Table 84 - Cumulative Practices Required to Provide Needed Drainage, Subregion 1

Practices	Unit	1966	1980	2000	2020
Drainage Conduits and Ditches	Miles	983	2,443	3,903	4,423
Drainage Structures	No.	109	228	348	469

Source: Soil Conservation Service, C-NPRBS Data.

Erosion and Sedimentation

Larger irrigated acreage and requirements for more intensive cultivation to increase agricultural production will bring attendant requirements for installation of adequate conservation practices to minimize sediment production and erosion problems. Accomplishments of these conservation practices will prevent the present erosion problem area (221,900 acres) from becoming any larger.

Steeply sloping lands, erosive soils, excess water, and fluctuating streamflows all contribute to the erosion problem. One of the most serious facets of the erosion problem is associated with streambank erosion.

The necessary practices to treat and protect areas with an erosion problem, as well as to maintain other areas in a stable condition, are shown in table 85.

Table 85 - Cumulative Practices to Satisfy Erosion Control Needs, Subregion 1

Practices	Unit	1966	1980	2000	2020
Grade Stabilization Structures	No.	146	303	460	620
Diversions	Miles	42	80	122	160
Ditch Bank Seeding	Miles	143	315	440	610
Crop Residue Use	1000 Acs.	490.7	701	850	1,096
Grassed Waterways	Acres	4.6	9	13	17
Conservation Cropping Systems	1000 Acs.	566.5	755	944	1,172
Pasture and Hay Land Planting	1000 Acs.	151.9	202	252	302

Source: Soil Conservation Service, C-NPRBS Data.

Flooding

More intensive use of all land and water resources will require additional flood protection measures. The most critical needs will be in the urban, industrial areas, and intensively cropped areas. Table 86 shows the projected stream channel and diking measures necessary in cropland areas to minimize local flooding.

Table 86 - Cumulative Cropland Flood Prevention Practices, Subregion 1

Practice	Unit	1966	1980	2000	2020
Stream Channel Improvement	Miles	124	231	353	476
Dikes & Levees	Miles	24	153	284	384
Streambank Protection	Miles	44	187	319	422
Stream Channel Stabilization	Miles	8	19	30	42

Source: Soil Conservation Service, C-NPRBS Data.

Croplands require specialized treatment measures related to intensity of use and production requirements. The goal is optimum production with a minimum of soil and water loss.

Program Costs

The costs of applying conservation practices which were discussed in the future needs section are scheduled in table 87. The costs are based on constant 1969 dollars. Approximately 20 percent of the total dollars needed between 1966 and 2020 will be furnished from public funds.

Table 87 - Estimated Cost of Cropland Conservation Practices, Subregion 1

Item	Water Conservation	Drainage	Erosion Control	Flood Prevention	Total
			(1,000 dollars)		
1966-1980					
Private Funds	261,415	1,085	60,524	1,542	324,566
Public Funds	82,552	343	19,113	487	102,495
Technical1/	8,255	342	716	183	9,496
Total	352,222	1,770	80,353	2,212	436,557
1980-2000					
Private Funds	532,598	1,796	74,818	2,679	611,891
Public Funds	141,577	477	19,888	711	162,653
Technical1/	16,180	546	8,524	305	25,555
Total	690,355	2,819	103,230	3,695	800,099
2000-2020					
Private Funds	899,302	2,068	107,903	3,597	1,012,870
Public Funds	184,194	549	38,683	956	224,382
Technical1/	26,004	628	12,293	410	39,335
Total	1,109,500	3,245	158,879	4,963	1,276,587

1/ Includes public and private costs.
Source: *Soil Conservation Service, C-NPRBS Projections.*

Forest Land

Increasing requirements for wood products in competition with other forest uses will cause mounting demands on the forest lands of the subregion. This will require accelerating levels of watershed protection, reduction in present sediment levels and increased streamflows through cover management. These practices go hand-in-hand with the structures and other projects designed to develop the water resources of the subregion. This section translates these needs into definite structural and nonstructural programs, costed in 1969 dollars.

Watershed Protection

Standards of watershed protection applied to the logging and road construction requirements, as outlined in table 67, are projected to improve on the public forest lands. Similar requirements will be necessary for the private areas, especially on sites with high erosion or sediment yield potential. Table 88 gives the anticipated total cost of such measures accumulated through the

Table 88 - Projected Costs for Watershed Protection Practices, Forest Land, Subregion 1

Practices	Unit	Total Units1/	Total Cost1/ ($1,000)
PUBLIC FOREST LAND			
Logging Disturbance Treatment	Ac.	295,000	8,850
Harvest Road Treatment2/	Mi.	23,600	5,900
Other Watershed Requirements3/	Ac.	13,118,000	251,400
Total Cost			266,150
PRIVATE FOREST LAND			
Logging Disturbance Treatment	Ac.	182,000	4,550
Harvest Road Treatment	Mi.	14,500	2,900
Other Watershed Requirements	Ac.	5,045,000	111,780
Total Cost			119,230
TOTAL ALL LAND			
Logging Disturbance Treatment	Ac.	477,000	13,400
Harvest Road Treatment	Mi.	38,100	8,800
Other Watershed Requirements	Ac.	18,163,000	363,130
Total Cost			385,330

1/ Total for 55-year period 1965-2020. Costs in 1969 dollars.
2/ Includes road maintenance.
3/ Includes watershed surveys, plans, fire protection, timber cultural practices, special road requirements, and other indirectly related items.

year 2020. These costs are based on the assumption that: (1) On the public forest lands, controls through timber sale and construction contracts are adequate if properly applied, and (2) on the private forest lands, the minimum required will be about equal to that presently applied on the public lands.

At this rate, the recurrent watershed protection measures applied on active timber sale and other operating areas will cost about $4,800,000 annually on the public forest lands and should cost $2,200,000 on the private. This should be considered the recurrent cost of the existing watershed protection programs, extended through the end of the planning period. Converted to total costs, the amount necessary to maintain the productive condition of the forest watersheds with the increased demands through the year 2020 is $385,330,000.

Watershed Rehabilitation

The forest areas most in need of rehabilitation and the areas where such work would accomplish the most in terms of sediment reduction, are the areas in the high sediment yield categories. These areas are presently contributing over 400 acre-feet per year or 30 percent of the total sediment load from the forest lands in the subregion. Acreage requiring treatment and the amount that should be accomplished by time periods 1980, 2000, and 2020 are listed in table 89. The expected sediment reduction through the application of these measures is listed in table 90.

Table 89 - Projected Watershed Rehabilitation Programs, Forest Land, Subregion 1

Program	Unit	1980 Amount	1980 Cost 1/ ($1,000)	2000 Amount	2000 Cost 1/ ($1,000)	2020 Amount	2020 Cost 1/ ($1,000)
FEDERAL LANDS							
Land Treatment	Ac.	2,800	583	3,700	872	4,000	931
Stream Rehabilitation	Mi.	1,532	2,794	2,011	3,696	1,956	3,598
Road Rehabilitation	Mi.	740	376	1,045	562	966	512
Total Cost			3,753		5,130		5,041
NON-FEDERAL LANDS							
Land Treatment 2/	Ac.	69,500	2,578	54,000	2,934	46,500	2,950
Stream Rehabilitation	Mi.	468	4,312	389	1,927	419	2,100
Road Rehabilitation	Mi.	610	22	945	35	969	36
Total Cost			6,912		4,896		5,086
TOTAL ALL LANDS							
Land Treatment	Ac.	72,300	3,161	57,700	3,806	50,500	3,881
Stream Rehabilitation	Mi.	2,000	7,106	2,400	5,623	2,375	5,698
Road Rehabilitation	Mi.	1,350	398	1,990	597	1,935	548
Total Cost			10,665		10,026		10,127

1/ In 1969 dollars
2/ SCS River Basin Survey Data.

The overall expected sediment reduction is 18 percent, or 242 acre-feet, primarily from treatment of the high and very high yield areas. This reduction represents that part of the sediment yield caused principally by past land use activities.

In addition to the needs for sediment reduction on the presently eroding forest lands, nonrecurrent work will be required on any future burn areas and other lands directly related to future water storage projects. These sediment sources, if any, will be treated as required. Hence, the 18 percent overall

Table 90 - Expected Annual Sediment Reduction, Forest Land Rehabilitation, Subregion 1

Present Yields1/	Acres (1,000)	Total Sed. Yield (Ac-Ft./Yr.)	Acres Treated2/	Sediment Reduction (Ac-Ft./Yr.)
Very low	15,276.1	477	-	-
Low	1,850.0	289	-	-
Medium	600.0	187	-	-
High	510.0	399	369,000	230.8
Very high	6.0	14	6,000	11.7
Total	18,242.1	1,366		242.5
		Total reduction percent		18

1/ Data from table 66.
2/ Data from table 89. Miles treated converted to acres.

sediment reduction is that amount possible without catastrophic fire or other natural disaster to create new sources.

Water Yield Improvement

The projected water yield improvement opportunities and the amount that should be accomplished by time periods 1980, 2000, and 2020 are shown on table 91. Timber cover on the private forest lands is logged principally to meet silvicultural requirements. Cutting cycles do not consider adjustments for downstream water needs. Therefore, neither water yield improvement practices nor benefits are estimated, although some benefit does occur.

Table 91 - Projected Water Yield Improvement Practices, Public Forest Land, Subregion 1

Program	Unit	1980 Amount	1980 Cost1/ ($1,000)	2000 Amount	2000 Cost1/ ($1,000)	2020 Amount	2020 Cost1/ ($1,000)
Cover Manipulation2/	Ac.	6,600	123	6,600	540	6,600	540
Snowpack Management	Mi.	200	10,000	300	15,000	120	6,000
Water Spreading3/	Ac.	5,000	250	6,000	300	6,800	340
Total Cost			10,373		15,840		6,880

1/ In 1969 dollars.
2/ Includes type conversion and riparian vegetation management.
3/ Planned for altering timing of runoff or ground-water recharge, not for irrigation or other resource activity.

Total Program Costs

The total estimated cost of forest watershed protection and land treatment programs through the year 2020 may be expressed as follows:

	Cost ($1,000)
Watershed Protection	385,330
Watershed Rehabilitation	30,818
Water Yield Improvement	33,093
	449,241

Rangeland

Measures and Practices for Watershed Protection

Measures and practices to satisfy future needs for rangeland watershed protection, rehabilitation, and improvement are presented in tables 92, 93, and 94. Most of these which improve watershed conditions have other management objectives or purposes. A combined total of 1.1 million acres of cover improvement and soil

Table 92 - Required Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, 1966 to 1980, Subregion 1

Measures & Practices	Units	Land Ownership Public[2/]	Private	Total	Watershed Purposes[1/] (1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	18,000	32,400	50,400	-	x	x	-
Brush Control	Acres	12,500	22,400	34,900	-	x	x	-
Weed Control	Acres	99,600	179,400	279,000	-	x	x	-
Fertilizing	Acres	12,000	21,500	33,500	-	-	x	-
Contouring, Pitting, Furrowing	Acres	23,500	42,200	65,700	x	x	x	-
Deep Tillage	Acres	5,000	9,100	14,100	-	x	-	-
Stream & Bank Stabilization	Acres	1,400	2,600	4,000	-	x	x	x
Waterspreading	Acres	800	1,500	2,300	x	x	x	-
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	14,000	25,100	39,100	-	x	x	-
Reducing Excessive Grazing Use	Acres	5,700	10,400	16,100	-	x	x	-
Livestock & Game Water Facilities	Number	200	400	600	-	x	x	-
Special Fire Control	Acres	79,200	142,500	221,700	-	x	x	x
Road Stabilization								
Existing Roads	Miles	100	200	300	x	x	x	-
New Roads	Miles	30	50	80	x	x	x	x
Pollution Abatement	Miles	4	7	11	-	-	x	-
Water Control Structures								
Ponds & Small Reservoirs	Number	45	80	125	-	x	x	-
	Acre Ft.	300	500	800	-	x	x	-
Detentions	Number	70	130	200	x	x	x	x
	Cu. Yds.	11,600	21,000	32,600	x	x	x	x
Check Dams (Gully Plugs)	Number	55	100	155	x	x	x	x
	Cu. Yds.	3,400	6,100	9,500	x	x	x	x
Diversions	Number	25	50	75	x	x	x	-
	Cu. Yds.	119,900	215,900	335,800	x	x	x	-

1/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4-Flood & Debris Control.

2/ Includes Federal, State, County, and Municipal Ownership.

Source: Data collected from land management agencies specifically for the C-NP Study.

Table 93 - Required Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, 1981 to 2000, Subregion 1

Measures & Practices	Units	Land Ownership Public[2/]	Land Ownership Private	Total	Watershed Purposes[1/] (1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	13,400	24,300	37,700	-	x	x	-
Brush Control	Acres	5,700	10,400	16,100	-	x	x	-
Weed Control	Acres	72,600	130,700	203,300	-	x	x	-
Fertilizing	Acres	24,500	44,000	68,500	-	-	x	-
Contouring, Pitting, Furrowing	Acres	16,400	29,500	45,900	-	x	x	-
Deep Tillage	Acres	2,900	5,200	8,100	-	x	-	-
Stream & Bank Stabilization	Acres	700	1,300	2,000	-	x	x	x
Waterspreading	Acres	2,500	4,400	6,900	-	x	x	-
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	1,000	1,700	2,700	-	x	x	-
Reducing Excessive Grazing Use	Acres	5,700	10,400	16,100	-	x	x	-
Livestock & Game Water Facilities	Number	500	800	1,300	-	x	x	-
Special Fire Control	Acres	79,200	142,500	221,700	-	x	x	x
Road Stabilization								
Existing Roads	Miles	60	100	160	x	x	x	x
New Roads	Miles	25	40	65	x	x	x	x
Pollution Abatement	Miles	50	90	140	-	-	x	-
Water Control Structures								
Ponds & Small Reservoirs	Number	40	80	120	-	x	x	-
	Acre Ft.	100	200	300	-	x	x	-
Detentions	Number	20	35	55	x	x	x	x
	Cu. Yds.	3,100	5,600	8,700	x	x	x	x
Check Dams (Gully Plugs)	Number	40	80	120	x	x	x	-
	Cu. Yds.	400	800	1,200	x	x	x	-
Diversions	Number	30	50	80	x	x	x	-
	Cu. Yds.	144,500	260,200	404,700	x	x	x	-

1/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4-Flood & Debris Control.

2/ Includes Federal, State, County, and Municipal Ownership.

Source: Data collected from land management agencies specifically for the C-NP Study.

Table 94 - Required Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, 2001 to 2020, Subregion 1

Measures & Practices	Units	Land Ownership Public[2/]	Land Ownership Private	Total	Watershed Purposes[1/] (1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	19,600	35,400	55,000	-	x	x	-
Brush Control	Acres	10,100	18,100	28,200	-	x	x	-
Weed Control	Acres	15,800	28,500	44,300	-	x	x	-
Fertilizing	Acres	23,000	41,500	64,500	-	-	x	-
Contouring, Pitting, Furrowing	Acres	3,500	6,200	9,700	-	x	-	-
Stream & Bank Stabilization	Acres	800	1,300	2,100	-	-	x	x
Waterspreading	Acres	2,900	5,200	8,100	x	x	x	-
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	500	1,000	1,500	-	x	x	-
Reducing Excessive Grazing Use	Acres	10,100	18,100	28,200	-	x	x	-
Livestock & Game Water Facilities	Number	400	600	1,000	-	x	x	-
Extra Fire Control	Acres	79,200	142,500	221,700	-	x	x	x
Road Stabilization								
Existing Roads	Miles	45	75	120	x	-	x	-
Pollution Abatement	Miles	35	65	100	-	-	x	-
Water Control Structures								
Ponds & Small Reservoirs	Number	40	70	110	x	x	x	-
	Acre Ft.	300	600	900	x	x	x	-
Detentions	Number	30	50	80	x	x	x	x
	Cu. Yds.	2,900	5,200	8,100	x	x	x	x
Check Dams (Gully Plugs)	Number	35	65	100	x	x	x	-
	Cu. Yds.	400	600	1,000	x	x	x	-
Diversions	Number	35	65	100	x	x	x	-
	Cu. Yds.	18,000	32,400	50,400	x	x	x	-

1/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4-Flood & Debris Control.

2/ Includes Federal, State, County, and Municipal Ownership.

Source: Data collected from land management agencies specifically for the C-NP Study.

stabilization practices are required on rangeland between 1966 and 2020. Many of these will be recurring actions, and a combination of practices may be applied on some of the same range areas. Bank stabilization by revegetation and other structural measures will be required along approximately 400 miles of streams or reservoirs.

Livestock grazing will be restricted to a smaller area as total rangeland acreage is reduced and as wildlife and recreational demands receive increased emphasis. This will require a continual adjustment of grazing use between 1966 and 2020 to assure that such use is compatible with range condition and grazing capacity. Improved livestock control and distribution will require construction of about 43,300 miles of livestock fencing and development of 2,900 livestock and game water facilities. Control of range fires is essential to protection of the forage crop and watershed cover, and special fire prevention efforts will be required on about 665,000 acres. Some 600 miles of existing roads and 150 miles of new roads will require ditches and culverts to control runoff; mulching, fertilizing, or seeding cut banks and fills; and protection of culvert outfalls.

Erosion and Sediment Yield Improvement

The range areas most in need of rehabilitation in terms of sediment reduction are the areas in the "High" and "Medium" sediment yield categories shown on table 70. These areas represent about 33 percent of the total range acreage and contribute 338 acre-feet of sediment per year or 68 percent of the total sediment derived from rangeland. Most of the measures and practices shown on tables 92, 93, and 94 for erosion and water quality control will be applied to areas of higher sediment yield. Reduction or redistribution of grazing use on some areas and improved vegetative cover should result in a reduction of approximately 64 percent of the annual sediment yield from 497 acre-feet in 1966 to 180 acre-feet in 2020 (table 95).

Improved Range Condition and Capacity

Estimated future range improvement, shown on table 96, will result, in part, from accomplishment of required measures and practices shown in tables 92, 93, and 94 and, in part, from other management practices. In 1966 only 26 percent of the range was in good condition (including seeded areas). With scheduled improvements, good condition range should be increased to 64 percent by 2020, or from 440,000 acres to 796,000 acres. Poor condition range, which in 1966 amounted to 35 percent of all rangeland, will be decreased 15 percent by 2020.

Table 95 - Annual Sediment Yield Projections from Rangeland, Subregion 1

Sediment Yield Categories[1/]	1966	1980	2000	2020
		Rangeland Acreage (1,000 acres)		
Very Low	768.8	724.7	829.8	832.3
Low	373.8	345.8	386.4	380.4
Medium	522.2	346.8	184.1	24.3
High	33.3	21.7	10.7	-
Very High	-	-	-	-
Total	1,698.1	1,439.0	1,411.0	1,237.0
Percent Change from 1966	.0	-15.3	-16.9	-27.2
		Annual Sediment Yield (Acre-Feet)		
Very Low	72	68	78	78
Low	87	81	90	89
Medium	286	190	101	13
High	52	34	17	-
Very High	-	-	-	-
Total	497	373	86	180
Percent Change from 1966	.0	-25	-43	-64

1/ Very Low through Very High categories represent generalized range areas on which annual sediment yield per square mile averages .06, .15, .35, 1.00, and 2.75 acre-feet, respectively.

Table 96 - Estimated Potential Rangeland Improvement, Subregion 1

Range Type and Condition	1966 Acres (1,000)	1966 AUM's (1,000)	1980 Acres (1,000)	1980 AUM's (1,000)	2000 Acres (1,000)	2000 AUM's (1,000)	2020 Acres (1,000)	2020 AUM's (1,000)
Grassland								
Good	317.7	99.3	345.4	107.9	433.0	135.3	487.2	152.2
Fair	449.3	64.2	320.5	45.8	245.5	35.1	125.1	17.9
Poor	376.4	30.1	260.3	20.8	199.6	16.0	119.3	9.5
Seeded Range	70.9	23.6	102.8	34.3	130.9	43.6	153.0	51.0
Total	1,214.3	217.2	1,029.0	208.8	1,009.0	230.0	884.6	230.6
Sagebrush								
Good	1.5	.3	11.8	2.3	35.5	7.1	47.2	9.5
Fair	61.2	6.8	48.7	5.4	36.8	4.1	29.7	3.3
Poor	86.6	4.9	66.0	3.8	51.8	2.9	31.8	1.8
Total	149.3	12.0	126.5	11.5	124.1	14.1	108.7	14.6
Other Brush								
Good	50.2	12.5	63.0	15.7	92.6	23.2	108.7	27.2
Fair	160.6	20.1	126.2	15.8	125.2	15.6	100.7	12.6
Poor	123.7	4.2	94.3	3.2	60.1	2.0	34.3	1.1
Total	334.5	36.8	283.5	34.7	277.9	40.8	243.7	40.9
Total								
Good[1/]	440.3	135.7	523.0	160.2	692.0	209.2	796.1	239.9
Fair	671.1	91.1	495.4	67.0	407.5	54.8	255.5	33.8
Poor	586.7	39.2	420.6	27.8	311.5	20.9	185.4	12.4
Grand Total	1,698.1	266.0	1,439.0	255.0	1,411.0	284.9	1,237.0	286.1
Average AC/AUM	6.4		5.6		5.0		4.3	
Percent Change from 1966	.0	.0	-15.3	-4.1	-16.9	+7.1	-27.2	+7.5

1/ Includes seeded range.
Source: Table 69, "Present Status" rangeland narrative. Future estimates for this study are based on representative on-site surveys for production guides with consideration to the capability of the range for improvement with proper management and utilization.

By 2020, the subregional acreage of good condition range, much as this area near Philipsburg, Montana, is expected to more than double with a significant increase in grazing capacity. Along with additional water developments, this will help to relieve grazing pressure on other areas in need of watershed improvement. (SCS Mt-10156)

The 1966 range capacity of 266,000 AUMs is expected to increase to 286,000 AUMs in 2020 (an 8 percent rise), although total rangeland acreage will decline 460,000 acres or 27 percent during the period. Even with this improvement in range condition and capacity, range forage production will only provide about 1.8 percent of the anticipated demand for livestock production in 2020, compared to 3.9 percent in 1966.

Estimated Program Investment Costs

Investment cost estimates (based on constant 1969 dollars) are given in table 97 for all future measures and practices shown previously. Cover improvement and soil stabilization programs will require $13.9 million between 1966 and 2020, or 68 percent of the total rangeland watershed program costs of $20.3 million. Watershed oriented land management practices require $5.8 million or 29 percent of total program costs, and water control structures require $600,000 or 3 percent of total costs.

Table 97 - Estimated Cost of Required Measures and Practices for Watershed Protection and Rehabilitation of Rangeland by Major Types of Watershed Programs, Subregion 1 1/

Major Types of Watershed Programs	1966 to 1980 ($1000)	1980 to 2000 ($1000)	2000 to 2020 ($1000)	Total ($1000)
		Public Land		
Cover Improvement and Soil Stabilization	2,365.7	1,279.1	1,330.7	4,975.5
Watershed Oriented Land Management Practices	1,531.8	303.1	256.2	2,091.1
Water Control Structures	76.4	69.7	55.3	201.4
Total	3,973.9	1,651.9	1,642.2	7,268.0
		Private Land		
Cover Improvement and Soil Stabilization	4,378.5	2,360.6	2,184.9	8,924.0
Watershed Oriented Land Management Practices	2,763.4	510.3	462.3	3,736.0
Water Control Structures	136.5	133.7	96.8	367.0
Total	7,278.4	3,004.6	2,744.0	13,027.0
		Total		
Cover Improvement and Soil Stabilization	6,744.2	3,639.7	3,515.6	13,899.5
Watershed Oriented Land Management Practices	4,295.2	813.4	718.5	5,827.1
Water Control Structures	212.9	203.4	152.1	568.4
Total	11,252.3	4,656.5	4,386.2	20,295.0

1/ *Based on measures and practices shown on tables 92, 93, and 94, with* constant 1969 dollars.

Based on the present ratio of rangeland ownership, an estimated $13.0 million will be needed for the private range (64 percent of total requirements), and the public range will require $7.3 million (36 percent of the total).

Other Land

Other land must increase by approximately 317,000 acres by the year 2020 in order to meet projected needs for urban growth, commercial and industrial development, roads, water storage, and recreational expansion. This increase will occur by a shift from cropland, forest land, and rangeland. Erosion is a major problem during the transition period.

Flood protection in urban areas will be greatly enhanced by the same flood detention reservoirs and practices listed in the

cropland sections. These same reservoir sites can incorporate multiple-use storage for recreation, municipal, and industrial use. Enlarged or improved channels, dikes, and levees will provide additional flood protection. Land treatment measures, which were listed previously, will help prevent damages to roads, bridges, farmsteads, and urban areas. Prevention of costly silt accumulation in the reservoirs and channels will be an additional effect.

Soil surveys and interpretive analyses will provide essential basic data to adequately plan new urban developments needed due to population increases. These surveys would provide planners necessary information to effect future land use changes.

Present urban areas must be protected by dikes and channel enlargement. New developments can be zoned away from floodplain areas. Land treatment and structural measures are needed on adjacent lands during construction and development to minimize the problems. Flood flows which start on adjacent lands can be treated at the source.

Sediment, which causes damage to urban areas, roads, and other developments, generally originate on adjacent cropland, forest land, and rangeland. Treatment of these lands as discussed in the respective sections is very important for the protection of other lands from sediment damages. It is, therefore, evident that many of the structures and land management measures necessary to provide watershed protection and improvement of other land have been included and costed elsewhere in this appendix and in Appendices VII, Flood Control; IX, Irrigation; XI, Municipal and Industrial Water Supply; and XII, Water Quality and Pollution Control.

One significant installation and maintenance problem involves treatment of lands on which the primary benefit from the treatment is downstream. The landowners are reluctant to make needed investments because they do not receive the benefits associated with the works of improvement. Conversely, those who benefit hesitate because they do not own the land on which the practices are applied. Educational programs must be expanded to make urban dwelling owners aware of the value of upstream land treatment measures and benefits they may receive from such expenditures.

S U B R E G I O N 2
U P P E R C O L U M B I A

PRESENT STATUS

Subregion 2 is bounded on the west by the crest of the Cascades and by the ridge separating the Yakima and Columbia Rivers; on the north by the Canadian border; and on the east by the Pend Oreille, Spokane, Palouse, and Snake River drainages. It has a total area of 14.4 million acres including 288,100 acres of large water bodies. About 52 percent is in private ownership and the balance is public land. Generalized cover and land use for the subregion is shown in figure 14 and table 98.

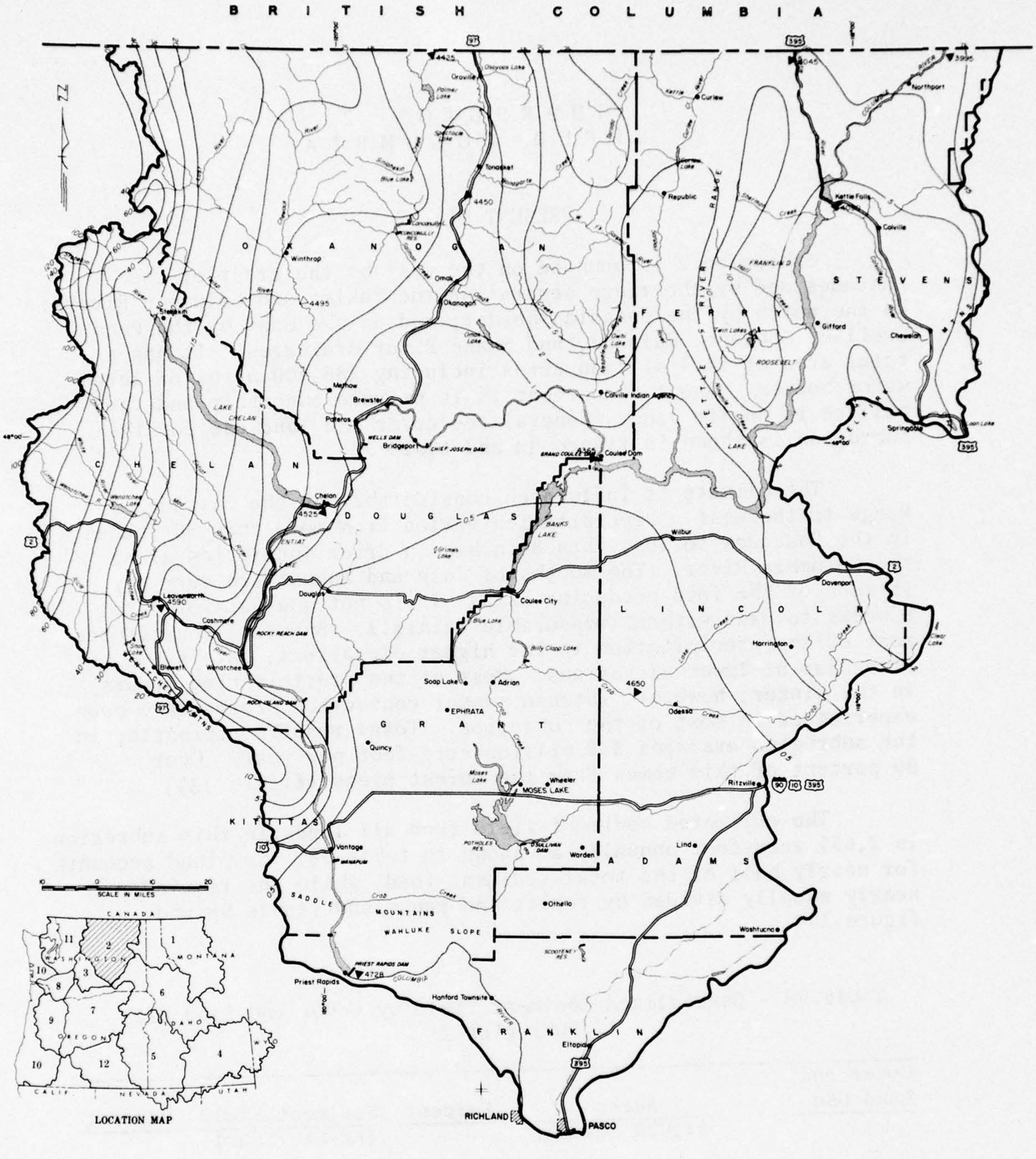
The climate is influenced considerably by the Cascade Range to the west. Precipitation varies from more than 50 inches in the Cascades to less than 8 inches in drier localities along the Columbia River. The months of July and August are very dry in much of the food producing area. It is not unusual for 4 to 6 weeks to pass without measurable rainfall. Snowfall constitutes most of the precipitation in the higher elevations, but is irregular at lower elevations. Most of the precipitation occurs in the winter; however, intense summer convection storms have been experienced in most of the subregion. Total runoff originating in the subregion averages 3.8 million acre-feet per year. Over 90 percent of this comes from the forest areas (figure 13).

The estimated sediment yield from all lands in this subregion is 2,651 acre-feet annually as shown in table 98. Cropland accounts for nearly half of the total sediment load, while the remainder is nearly equally divided by forest and rangeland (table 98 and figure 15).

Table 98 - Generalized Sediment Yield by Cover and Land Use
Subregion 2

Cover and Land Use	Acres (1,000 acres)	Percent	Sediment Yield (Ac-Ft./Year)	Percent
Cropland	3,308.8	23	1,308	49
Forest Land	5,652.1	40	548	21
Rangeland	4,583.9	33	709	27
Other Land	536.0	4	86	3
Total	14,080.8	100	2,651	100

Source: Derived from figures 14 and 15 and Appendix IV.



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

MEAN ANNUAL RUNOFF IN INCHES

UPPER COLUMBIA SUBREGION 2

1968

FIGURE 13

Explanation

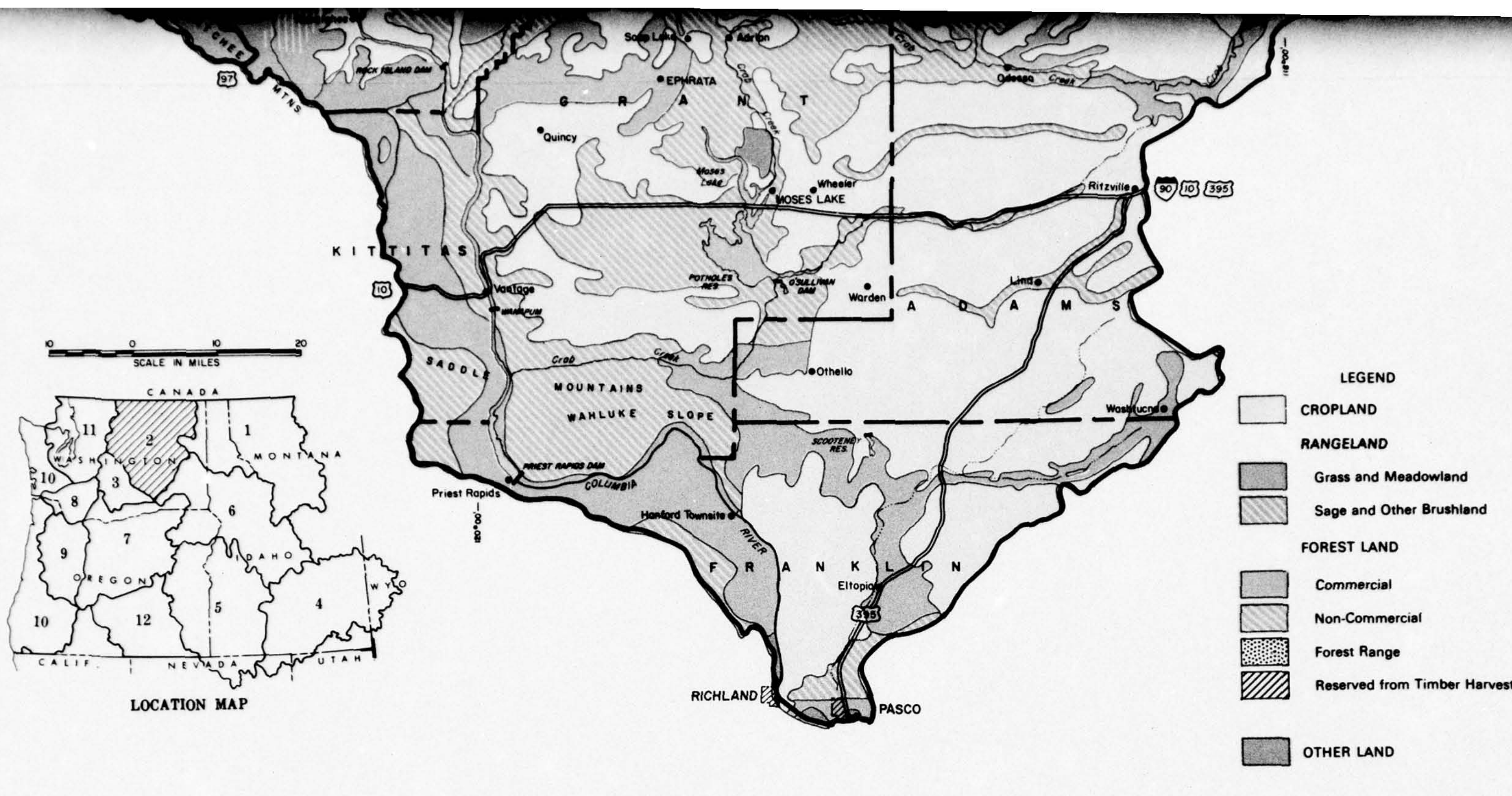
▲3960 STREAM GAGE - RECORDING

Notes

(1) MEAN ANNUAL RUNOFF ISOPLETHS FOR NATURAL FLOW CONDITIONS WERE DERIVED USING OBSERVED STREAM FLOWS, CLIMATOLOGICAL DATA, DEPLETIONS, AND PHYSIOGRAPHIC FEATURES OF THE BASIN FOR THE PERIOD 1931-1960.

(2) STREAM GAGING STATIONS SHOWN ARE SELECTED STATIONS AND ARE NOT THE ONLY STATIONS USED IN PREPARING THE RUNOFF MAP.

BRITISH COLUMBIA
120°00'
118°00'
97
395
Tonasket
Spectacle Lake
Winthrop
Omak
Okanogan
Stehekin
Brewster
Pateros
LAKE CHELAN
Bridgeport
WELLS DAM
CHIEF JOSEPH DAM
GRAND COULEE DAM
Colville
Springdale
Loon Lake
48°00'
Chelan
DOUGLAS
BANKS LAKE
Grimes Lake
Wilbur
Davenport
2
Douglas
Coulee City
Leavenworth
Cashmere
ROCKY REACH DAM
Blue Lake
Billy Clapp Lake
Wenatchee
Wenatchee Lake
Blewett
Soap Lake
Adrian
EPHRATA
ROCK ISLAND DAM
Harrington
Clear Lake
Odessa
Crab Creek
GRANT
Quincy
Moses Lake
Wheeler
MOSES LAKE
Ritzville
90
10
MTNS.
KITTITAS
Warden
Lind
Entiat River
Mad River
Wenatchee River
LAKE ENTIAT



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

GENERALIZED COVER AND LAND USE

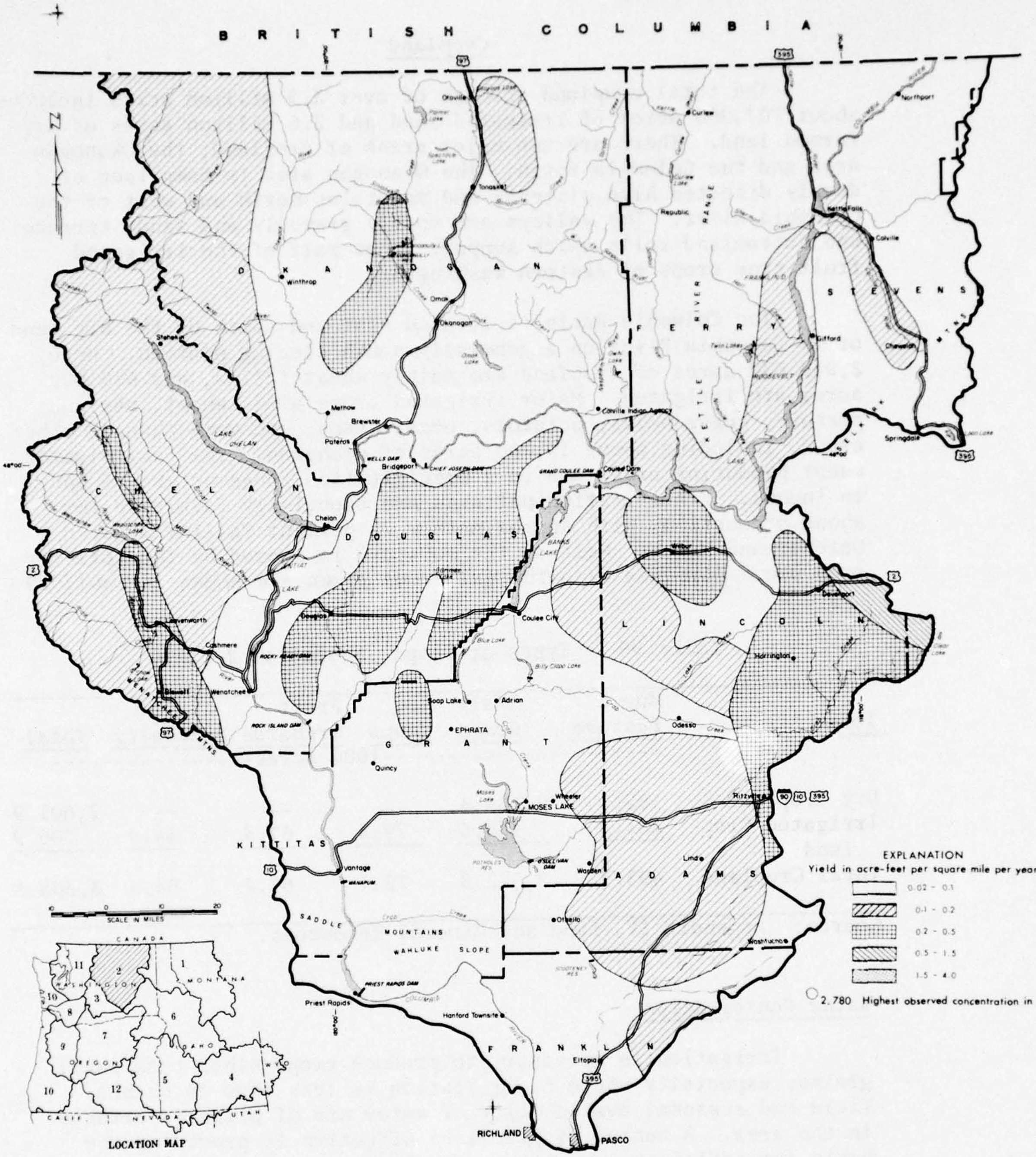
UPPER COLUMBIA, SUBREGION 2

1968

USDA-SCS-PORTLAND, OREG. 1970

FIGURE 14

2



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

GENERALIZED SEDIMENT YIELD

UPPER COLUMBIA SUBREGION 2

1968

FIGURE 15

Cropland

The total cropland acreage of over 3.3 million acres includes about 707,000 acres of irrigated land and 2.6 million acres of dry-farmed land. There are two major areas of cropland; the Okanogan area and the Columbia Basin. The Okanogan area is comprised of deeply disected high plateaus and mountains north and west of the Columbia River. The valleys are mostly gravelly and sandy terrace and bottomland soils which support about half of the irrigated fruit tree crops of eastern Washington.

The Columbia Basin is located east and south of the big bend of the Columbia River on a generally south sloping plateau. Here, 2,949,000 acres of cropland are mainly wheat-fallow, and 619,000 acres are irrigated. Major irrigated crops are: wheat, hay and pasture, sugar beets, potatoes, peas, beans, and more than 40 other crops, including about 19,000 acres of orchards. The nonirrigated wheat producing areas are in a precipitation range between 8 and 16 inches. Precipitation patterns are especially favorable for wheat production, with approximately 75 percent falling between October and March. Most of the moisture is stored by the soil for crop use. Acreages of principal crops grown are shown in table 99.

Table 99 - Types of Crops, Subregion 2, 1966

Item	Hay & Pasture	Small Grain	Row Crops	Fruit Orchards	Specialty	Total
	1000 Acres					
Dry Cropland	162.5	2,439.4	--	--	--	2,601.9
Irrigated Cropland	331.2	134.5	79.4	67.4	94.4	706.9
Total Cropland	493.7	2,573.9	79.4	67.4	94.4	3,308.8

Source: Appendix IV, Land and Mineral Resources.

Water Conservation

Irrigation is necessary to produce crops other than small grains, especially where precipitation is less than 14 inches. Yield and seasonal availability of water are of prime importance in the area. A number of practices effective in providing the basis for efficient irrigation are shown in table 100.

Table 100 - Water Conservation Practices Applied on Cropland, Subregion 2, 1966

Practice	Units	Total
Water Control Facilities	No.	10,534
Irrigation Water Conveyance Facilities	Miles	2,575
Water Storage Facilities	No.	834
Irrigation System, Surface	No.	1,812
Irrigation System, Sprinkler	No.	6,274
Land Shaping	1,000 Acs.	152
Irrigation Water Management	1,000 Acs.	160

Source: Soil Conservation Service Data.

In areas without reservoir storage, irrigation water supplies are often inadequate. Water availability and irrigation use by source are presented in table 101.

Table 101 - Water Availability and Irrigation Methods for Croplands, Subregion 2, 1966

Item	1,000 Acres	Percent
Water Source		
Streamflow	96.0	14
Ground Water	55.4	8
Reservoir Storage	555.5	78
Total	706.9	100
Area with adequate supply	670.4	95
Area with inadequate supply	36.5	5
Method of Application:		
Sprinkler	310.7	44
Flooding	396.2	56

Source: Soil Conservation Service, C-NPRBS Data.

Of the 706,900 acres irrigated, 55,400 acres are supplied from ground water, which is mostly used to irrigate small grain crops. The competition for available supplies is lowering the water table in some areas east of the Columbia Basin Project, resulting in a water shortage on 36,500 acres.

Systems for conveyance of irrigation water vary in degree of efficiency. For example, the Lake Chelan Conveyance System lost only 305 acre-feet (3 percent) of the 9,343 acre-feet entering the system, whereas the Methow River Conveyance System, of untreated earth canals and ditches, lost 35,735 acre-feet (45 percent) of the 79,348 acre-feet entering that system. (5)

Approximately 45 percent of irrigation is accomplished by sprinklers and 55 percent by surface methods. The use of sprinklers is increasing even though other methods are sometimes preferred for certain crops or for convenience.

Drainage

Drainage problems in cropland areas are generally the result of irrigation, caused sometimes because extra water is used to leach salt accumulations below root zones. This may, depending on the substrata, create wet areas at lower elevations. Approximately 107,000 acres of cropland have a wetness problem, mostly resulting from improper irrigation water management (table 102). Of this area, 76,600 acres have been drained and 30,400 acres still need drainage for optimum crop production.

Table 102 - Cropland Areas with a Wetness Problem
Subregion 2, 1966

Capability Class	Area (1,000 acres)
II	30
III	52
IV	25
Total	107

Source: Soil Conservation Service, C-NPRBS Data.

Wet areas have been drained by systems of open ditches or tile to provide more productive lands. Table 103 shows the drainage measures in this subregion.

Table 103 Drainage Practices Applied to Cropland
Subregion 2, 1966

Practices	Units	Total
Conduits and Ditches	Miles	914
Structures	No.	254

Source: Soil Conservation Service Data.

Erosion and Sedimentation

There are over 4 million acres of land suitable for cropland, of which 3.3 million acres are presently cultivated. Soil surveys indicate that more than 2.5 million acres of cropland have soils subject to erosion if not adequately treated (table 104).

Table 104 - Cropland Areas with an Erosion Potential
by Capability Class, Subregion 2, 1966

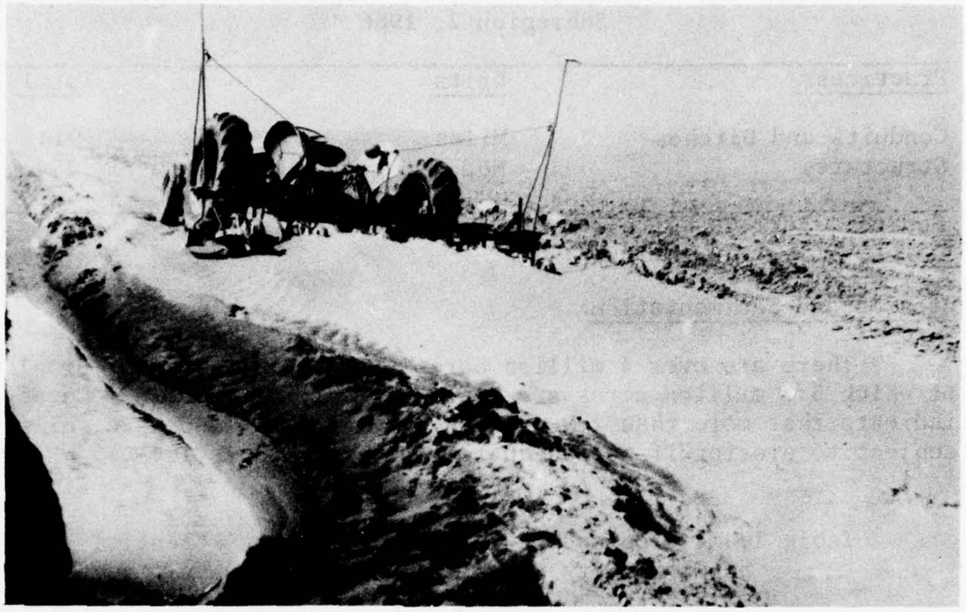
Capability Class	Total (1,000 acres)
II	385
III	1,825
IV	313
Total	2,523

Source: Soil Conservation Service, C-NPRBS Data.

Water erosion, as indicated on the generalized sediment yield map (figure 15), is common. Sediment production from the cultivated hill lands is the most serious problem associated with cropland. Most of the sediment is deposited on flatter lands, frequently destroying crops. It has been estimated that sediment deposition accounts for as much as 75 percent of the total crop lost through erosion. Sediment also increases the maintenance cost of irrigation ditches and shortens the life of storage reservoirs.

Although erosion damage is prevalent in all parts of the subregion, it is more severe in areas where the annual precipitation is over 10 inches. In these higher rainfall areas, most soil losses are from sheet and rill erosion on nonirrigated fields.

There are approximately 240,000 acres of soils susceptible to wind erosion, mostly in the southern part of the area. An average of 10 percent, or 24,000 acres, is estimated to be damaged



Wind erosion damage to land, structures, and crops is significant, and the monetary loss is tremendous. (SCS W-957-3)

each year. Most of the wind erosion damage is to coarse textured soils that lie north of Pasco, the west part of the Frenchman Hills, and smaller areas throughout the Columbia Basin. Fine textured soils are less susceptible to wind erosion and can usually be protected by maintaining a high rate of organic matter and careful tillage. Organic matter aids in the forming of soil aggregates that resist movement by wind. Wind erosion will often blow out newly seeded crops and bury established crops. When conveyance and drainage ditches are silted full, the water is diverted across fields causing severe water erosion.

The erosion control practices applied to date are shown in table 105.

Table 105 - Erosion Control Practices Applied on Cropland
Subregion 2, 1966

Practice	Units	Total
Grade Stabilization Structures	No.	402
Diversions and Terraces	Miles	49
Ditch Bank Seeding	Miles	10
Field Windbreak	Miles	233
Crop Residue Use	1,000 Ac.	1,239
Stubble Mulch	1,000 Ac.	633
Grassed Waterway	1,000 Ac.	3
Stripcropping	1,000 Ac.	16
Conservation Cropping System	1,000 Ac.	1,488
Pasture and Hayland Planting	1,000 Ac.	134

Source: Soil Conservation Service Data.

Flooding

Over 89,000 acres of cropland are subject to flooding caused by snowmelt and late spring and summer convection storms. The most severe floods usually occur when the soil is frozen. Cropland subject to frequent flooding is used principally for hay or pasture in order to minimize flood damage. The 1969 National Assessment of Streambank Erosion shows 397 miles of serious streambank erosion and 2,530 miles of moderate erosion.

The problems resulting from floods are soil erosion, sediment deposition, and water damage to crops and property. Crop damage is especially heavy from floods that occur during the growing season, but spring and winter floods also damage crops. The expense of removing debris and silt from fields, ditches, and stream channels is often prohibitive. The estimated average annual flood damages are nearly $4.6 million. The work that has been done in cropland areas to reduce flood damages is presented in table 106.

Table 106 - Flood Control Measures Applied on
Cropland Areas, Subregion 2, 1966

Practice	Amount (miles)
Stream Channel Improvements	180
Streambank Protection	48
Stream Channel Stabilization	2
Dikes and Levees	4

Source: Soil Conservation Service Data.

Forest Land

Forest land covers nearly 5.7 million acres or 40 percent of the land area in the subregion. About 80 percent is in Federal, State, and other public ownerships; 20 percent is in private. Of the total area, 80 percent is classed as commercial forest land and 20 percent is noncommercial.

This commercial forest land supports more than 37 billion board feet of merchantable timber, 85 percent on public land and 15 percent on private, and supplies the raw material for an industry that employs 42 percent of the subregion's manufacturing force. About 500 million board feet were harvested in 1964. In addition, both the commercial and noncommercial forest areas are widely used by domestic livestock and big game.

Forest areas are generally in a good condition, providing high quality water and low sediment yields. Forest land sediment yields, shown in table 107, account for about 20 percent of the annual sediment produced from all lands in the subregion.

Table 107 - Present Sediment Yield, Forest Land, Subregion 2

Sediment Yield Category	Acres (1,000)	Percent	Annual Sediment Yield: Acre-feet Per Square Mile	Annual Sediment Yield: Total Acre-feet	Percent
Very Low	3,113.1	55	0.02 - 0.1	97	18
Low	2,225.3	39	0.1 - 0.2	348	64
Medium	302.7	6	0.2 - 0.5	95	17
High	11.0	--	0.5 - 1.5	8	1
Very High	--	--	1.5 - 4.0	--	--
Total	5,652.1	100		548	100

Source: Derived from figures 14 and 15.

Half of the forest land is in the very low yield category with sediments produced principally by natural or geologic erosion. The balance is spread through the categories, where forest utilization activities and alpine glaciation are adding to the base load. Disturbed logging areas in these higher yield categories account for most of the present watershed rehabilitation work.

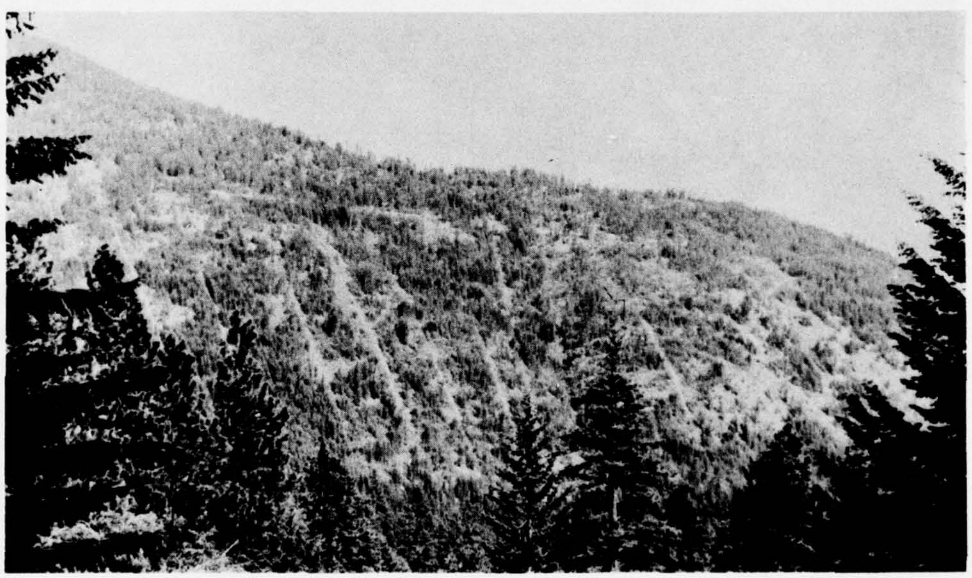
Watershed Protection

General timber harvesting methods include both clear-cutting and partial-cutting systems. Logs are removed by crawler or rubber-tired tractors, mobile cable yarders, and stationary and skyline cable systems. In the steeper terrain in the northwestern part of the subregion, the modified Wyssen type skyline system has been used successfully. This system permits log removal by pulling logs directly into the skyline and then lowering them by gravity to the landing below. In this manner, logs are delivered to the road with little damage to landscape, soil, or water values.

On the public and Indian forest lands, tractor trails are generally cross-drained and out-sloped. Cable skid trails and more critical tractor trails are also seeded to grass or other species to reduce sheet erosion. Temporary roads are cross-drained and logjams are removed from major streams.

Most roads are gravel surfaced and have permanent culverts. In key areas, particularly at the crossing points of major streams, excavated material is endhauled to prevent wastage into the water and exposed cutbank and fill slopes are seeded to grass.

Reforestation measures include both planting and direct seeding. Many areas also restock naturally. Advance reproduction and residual trees in the partial-cut areas are protected from damage by on-the-ground administrative controls. A summary of the harvest activities and protection practices is shown in table 108.



Skyline logging area, showing the narrow clear-cut block. This is the general appearance of a hillside cutover by this system. (Forest Service)

Table 108 - Average Annual Timber Harvest Activity, Subregion 2

	Unit	Public	Private	Total
Harvest Area	Ac.	35,000	20,000	55,000
Area Reforested 1/	Ac.	4,000	2,000	6,000
Slash Disposal Area	Ac.	20,000	4,000	24,000
Disturbed Area Treated 2/	Ac.	5,300	--	5,300
Harvest Road Required	Mi.	210	120	330
Harvest Road Treated 3/	Mi.	135	--	135

1/ Includes planting, seeding and site preparation. Balance adequately stocked or requires no regeneration work.
2/ Includes seeding, mulching, debris removal and cross-draining skid roads and logging areas.
3/ Cut and fill stabilization only.

Area under the skyline. Note the lack of ground disturbance on either side of the strip. (Forest Service)

Watershed Rehabilitation

About 6 percent of the forest land has serious erosion problems, producing over 100 acre-feet of sediment per year. Most of this results from water movement down abandoned logging roads and across areas logged off and overgrazed years ago. Work on public and Indian owned forest lands includes treatment of about 3,500 acres annually. Over 200 miles of road and 65 miles of stream are also treated each year (table 109). Most rehabilitation on private forest lands has been done through assistance programs of the U.S.D.A. Burned-over areas of the 28,000 acre Ardenvoir and Fourth of July Mountain fires were thus treated in 1968.

Table 109 - Average Annual Accomplishment, Watershed Rehabilitation Practices on Public Forest Land, Subregion 2

Practice	Unit	National Forest 1/	Public Domain	Indian Lands	State Lands 2/
Sheet Erosion Control	Ac.	200	300	3,000	-
Gully Stabilization	Mi.	-	-	-	-
Stream Clearance & Stabilization	Mi.	6	-	60	1
Existing Road & Trail Rehab. 3/	Mi.	60	-	150	5
Reservoir Protection	Ac.	-	-	-	-

1/ Average of period 1964-66
2/ Accomplishment to date principally on active timber sale areas (table 108).
3/ Includes abandoned roads
Source: Data furnished by agency as listed.

Rangeland

Rangeland in Subregion 2 amounts to 4.6 million acres or 33 percent of the total land area. About 2.9 million acres or 63 percent of all rangeland is privately owned. The public range covers 1.7 million acres of which 1.3 million acres is Federally owned land. Federal rangeland includes 326,100 acres of Bureau of Reclamation land; 235,400 acres in national forest status; 163,900 acres held in trust by the Bureau of Indian Affairs; 140,000 acres administered by the Bureau of Land Management; and 441,900 acres controlled by other Federal agencies. Rangeland acreage is discussed in Appendix IV, Land and Mineral Resources.

Present rangeland condition and grazing capacity is shown on table 110. Grass is the predominate cover on 66 percent of the

Table 110 - Rangeland Condition and Capacity, Subregion 2, 1966

Range Type and Condition	Public Acres (1,000)	Public AUM's (1,000)	Private Acres (1,000)	Private AUM's (1,000)	Total Acres (1,000)	Total AUM's (1,000)
Grassland						
Good	222.5	61.8	477.1	132.5	699.6	194.3
Fair	317.4	37.8	711.2	84.7	1,028.6	122.5
Poor	316.9	22.7	863.0	61.6	1,179.9	84.3
Seeded Range 1/	61.9	20.6	55.4	18.5	117.3	39.1
Total	918.7	142.9	2,106.7	297.3	3,025.4	440.2
Sagebrush						
Good	191.5	31.9	117.9	19.7	309.4	51.6
Fair	232.8	17.9	211.1	16.2	443.9	34.1
Poor	277.7	11.1	314.1	12.6	591.8	23.7
Total	702.0	60.9	643.1	48.5	1,345.1	109.4
Other Brush						
Good	18.2	4.6	30.9	7.7	49.1	12.3
Fair	26.0	2.6	44.4	4.4	70.4	7.0
Poor	34.7	1.5	59.2	2.6	93.9	4.1
Total	78.9	8.7	134.5	14.7	213.4	23.4
Total						
Good 2/	494.1	118.9	681.3	178.4	1,175.4	297.3
Fair	576.2	58.3	966.7	105.3	1,542.9	163.6
Poor	629.3	35.3	1,236.3	76.8	1,865.6	112.1
Grand Total	1,699.6	212.5	2,884.3	360.5	4,583.9	573.0
Percent Distribution	37.1	37.1	62.9	62.9	100.0	100.0
Average AC/AUM	8.0		8.0		8.0	

1/ Seeded range acreage was combined with good condition grassland in Appendix IV.
2/ Includes seeded range.
Source: C-NP Appendix IV, Subregion 2. Range production has been estimated for the C-NP Study from representative situations observed and recorded in on-site surveys. Estimates are based on perennial vegetation and proper utilization.

range, sagebrush on 29 percent, and other brush and shrubs on 5 percent. *The average grazing capacity is about 8 acres per animal unit month.*

Livestock operations developed rapidly in the mid-1800's on the broad, open bunchgrass areas of Central Washington, which offered easy means of raising cattle and sheep with a minimum of winter feeding. With the advent of extensive farming operations, financial returns from livestock became of secondary importance to grain farming. Widespread grazing use has altered the forage productivity and soil stability of the land, often with serious consequence to watersheds, the livestock industry, and to the local economy. Poor management, drought, recurrent fire, and rodent and insect damage all played a part in the deterioration of the range.

Since 1930, a number of range areas have been improved. Excessive grazing use has been reduced on about 1.1 million acres (24 percent of the total range). Still, only 26 percent of the range is in good condition, and 41 percent remains in poor condition with deficient vegetative cover and considerable accelerated erosion. In areas of less than 10 inches of precipitation, a major problem is erosion from wind action when

Under proper grazing management systems, rangelands will maintain adequate vegetative cover for soil and watershed protection while providing increased forage for livestock and wildlife. (Forest Service)

coarse textured soils are disturbed or left unprotected. Severe water damage usually occurs during heavy winter storms that come at infrequent intervals.

Sediment yield from rangeland is about 709 acre-feet annually (table 111), 27 percent of the total sediment from all lands in the subregion. About 359 acre-feet or 51 percent of the rangeland sediment comes from 850,000 acres or 18 percent of the land in the "High," "Medium," and "Low" sediment yield categories. The more serious sediment yield areas include 618,000 acres of predominantly grassland range and 232,000 acres of sage and shrub range cover, interspersed with agricultural cropland areas, mostly in Lincoln and Douglas counties of the Big Bend area.

Table 111 - Sediment Yield from Rangeland, Subregion 2, 1966

Sediment Yield 1/ Categories	Grassland	Sagebrush & Shurbs	Total	Percent
		Rangeland Acreage (1,000 Acres)		
Very Low	2,407.8	1,326.2	3,734.0	82
Low	275.8	126.7	402.5	9
Medium	330.9	97.3	428.2	9
High	10.9	8.3	19.2	-
Very High	-	-	-	-
Total	3,025.4	1,558.5	4,583.9	100
		Annual Sediment Yield (Acre-Feet)		
Very Low	226	124	350	50
Low	65	30	95	13
Medium	181	53	234	33
High	17	13	30	4
Very High	-	-	-	-
Total	489	220	709	100

Source: Derived from figures 14 and 15.

1/ Very Low through Very High categories represent generalized range areas on which annual sediment yield per square mile averages .06, .15, .35, 1.00, and 2.75 acre-feet, respectively.

Measures and Practices for Watershed Protection

Measures and practices accomplished through 1965 are shown on table 112. Most rangeland practices for watershed protection and improvement serve management objectives other than watershed improvement.

Cover improvement and soil stabilization practices have been applied on about 191,000 acres of rangeland. A combination of practices has been applied on certain areas, and some practices have been recurrent. About 25 percent of the 117,000 acres of range seeding was for erosion and water quality control, 15 percent was for reduced flows and water conservation, and 60 percent for forage production. Stabilization practices have been applied on some 1,000 acres above reservoirs or along streams (approximately 25 miles) for erosion protection by revegetation and other structural measures.

Table 112 - Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, Subregion 2, 1966

Measures & Practices	Units	Land Ownership			Watershed Purposes 1/			
		Public 2/	Private	Total	(1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation	Acres	61,900	55,400	117,300	-	x	x	x
Brush Control	Acres	10,600	31,400	42,000	-	x	x	x
Weed Control	Acres	10,800	18,400	29,200	-	x	x	x
Stream & Bank Stabilization	Acres	400	600	1,000	-	-	x	x
Waterspreading	Acres	200	1,700	1,900	-	x	x	-
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	700	1,100	1,800	-	x	x	-
Reducing Excessive Grazing Use	Acres	417,500	688,800	1,106,300	-	x	x	x
Livestock & Game Water Facilities	Number	500	900	1,400	-	x	x	x
Road Stabilization	Miles	1,000	NA	NA	x	x	x	x
Pollution Abatement	Miles	25	50	75	-	-	x	-
Water Control Structures								
Ponds & Small Reservoirs	Number	90	160	250	x	x	x	x
	Acre Ft.	170	280	450	x	x	x	x
Check Dams (Gully Plugs)	Number	20	30	50	-	-	x	x
	Cu. Yds.	25	45	70	-	-	x	x
Diversions	Number	40	60	100	x	x	x	x
	Cu. Yds.	13,400	22,800	36,200	x	x	x	x

1/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col 3.-Erosion & Water Quality Control; Col. 4-Flood & Debris Control.
2/ Includes Federal, State, County, and Municipal Ownership.
Source: Data collected from land management agencies specifically for the C-NP Study.

Considerable progress has been made in adjusting livestock grazing use to the grazing capacity of the range and achieving better livestock distribution. Excessive grazing use has been reduced on an estimated 1.1 million acres. Of importance in this reduction has been the development of grazing management systems which provide sufficient rest periods for natural revegetation of range cover. Some 40 percent of this reduction served the objective of erosion and water quality control, about 25 percent was for other watershed objectives, and 35 percent was for forage production. Development of about 1,400 livestock and game watering facilities and construction of about 1,800 miles of livestock control fence, have allowed more uniform utilization by game and livestock.

Watershed protection measures have been included in the maintenance and improvement of about 1,000 miles of public access roads and trails, as well as a number of roads on private rangeland.

Other Land

Other land covers 536,000 acres, which is 4 percent of the subregional land area. This category is composed of 6 percent or 30,800 acres of small water, 24 percent or 127,600 acres of roads and railroads, 14 percent or 74,400 acres of urban and industrial, 6 percent or 33,700 acres of farmsteads, and 50 percent or 269,500 acres of barren land.

A number of watershed problems have developed, principally on the more intensively used lands. Deficient quality or quantity

of water supplies for municipal, industrial, and rural domestic use is indicated in 59 study areas. Along with other water requirements, irrigation water is supplied to about 22,000 acres, mostly in urban areas and farmsteads. Approximately 3,600 acres in towns and cities are subject to flooding at frequent intervals. In addition, soils in some areas are not suitable for housing developments. Problems have developed with septic tank drain fields and high water tables occur in several areas. In locations with impermeable to slowly permeable soils, surface disposal of water has been complicated by the addition of paving on streets and houses and by the disruption of natural drainage ways.

Erosion is a common problem during urban and highway construction when the natural vegetative cover is destroyed. The areas most adversely affected by soil erosion are streams, canals, lakes, and reservoirs. Carrying capacities of streams and canals are frequently reduced by sediment deposition, and silt not only reduces the storage capacity of ponds and reservoirs, but also affects water quality.

As lands become more intensively used along rivers, streams, lakes, and reservoirs, water pollution is an increasing problem where planning and construction of this development is not strictly regulated.

FUTURE NEEDS

Population is projected to increase 123 percent from 193,500 in 1960 to 431,300 by 2020 with an accompanying demand for more urban lands and recreation or special use areas. Much of this increase will be associated with an expanding agricultural industry, although farm population is expected to drop 54 percent. While total cropland remains at about its current acreage, irrigated cropland is projected to expand to an additional 1.2 million acres. Urban and other special use areas will increase 126,000 acres, reservoir areas about 145,000 acres, and forest lands some 22,000 acres. These increases will occur mostly by expansion to adjacent rangeland, which will decrease about 284,000 acres by 2020 (table 113).

Table 113 - Projected Change in Cover and Land Use, Subregion 2

	1966	1980	2000	2020
		(1,000 acres)		
Cropland	3,309	3,451	3,345	3,300
Forest Land	5,652	5,624	5,653	5,674
Rangeland	4,584	4,363	4,360	4,300
Other Land	536	570	616	662
Total	14,081	14,008	13,974	13,936

Source: Appendix VI, Economic Base and Projections.

Cropland

At the present time, 30,400 acres of cropland have a drainage problem, over 89,400 acres are subject to flooding, 1,276,800 acres are eroding in varying degrees, and over 36,500 acres of irrigated land do not have a full season irrigation water supply. These problems limit the safe use of cropland to less than its potential. A major factor influencing requirements for cropland treatment is the projected increase in irrigation (table 114).

Table 114 - Projected Trends in Dry and Irrigated Cropland Subregion 2

Cropland	1966	1980	2000	2020
		(1,000 acres)		
Dry Farmed	2,602	2,209	1,897	1,434
Irrigated 1/	707	1,242	1,448	1,866
Total	3,309	3,451	3,345	3,300

1/ Approximately 97 percent of the projections shown in Appendix IX, Irrigation.
Source: Appendix VI, Economic Base and Projections.

Water Conservation

Projected agricultural needs will require an increase in irrigated cropland. In addition, water must be developed for those areas that have less than a full season supply, which at the present time is about 36,500 acres.

Management of irrigation water will improve from the present efficiency of 35 percent to 55 percent by 2020. This will be done

primarily through an increase in the use of sprinkler systems from 45 percent of the irrigated area to 87 percent by 2020. (table 115)

Table 115 - Projected Cumulative Trend in the Method of Irrigation on Cropland, Subregion 2

Item	Unit	1966	1980	2000	2020
Sprinkler Systems	1,000 Acs.	311	847	1,128	1,623
Surface Systems	1,000 Acs.	396	395	320	243
Total Area Irrigated	1,000 Acs.	707	1,242	1,448	1,866

Source: Soil Conservation Service, C-NPRBS Data.

Drainage

There are presently 107,000 acres of cropland with wetness as its major limiting factor. Some degree of drainage has been provided on 77,000 acres, leaving 30,000 acres to be drained (table 116).

Table 116 - Cumulative Cropland Areas Needing Drainage, Subregion 2

Item	1966	1980	2000	2020
		(1,000 acres)		
Wet Area	107	115	126	137
Projected Accomplishments	77	87	102	116
Remaining	30	28	24	21

Source: Soil Conservation Service, C-NPRBS Data.

Future irrigation is expected to increase this by another 30,000 acres in the next 50 years. Drainage facilities scheduled to be installed as part of the irrigation plan on the Columbia Basin Project will prevent wetness problems from developing on an estimated additional 530,000 acres.

Erosion and Sedimentation

Wind and water erosion control practices have been effective on about 1.2 million acres, and 1.3 million acres still require

attention. Protection measures in conjunction with cropping patterns and more irrigation should eliminate erosion problems on all but 191,000 acres by 2020 (table 117).

Table 117 - Cumulative Cropland Areas Needing Erosion Control
Subregion 2

Item	1966	1980	2000	2020
		(1,000 acres)		
Erosion Potential	2,523	2,408	2,319	2,260
Projected Accomplishments	1,246	1,413	1,917	2,069
Remaining	1,277	995	402	191

Source: Soil Conservation Service, C-NPRBS Data.

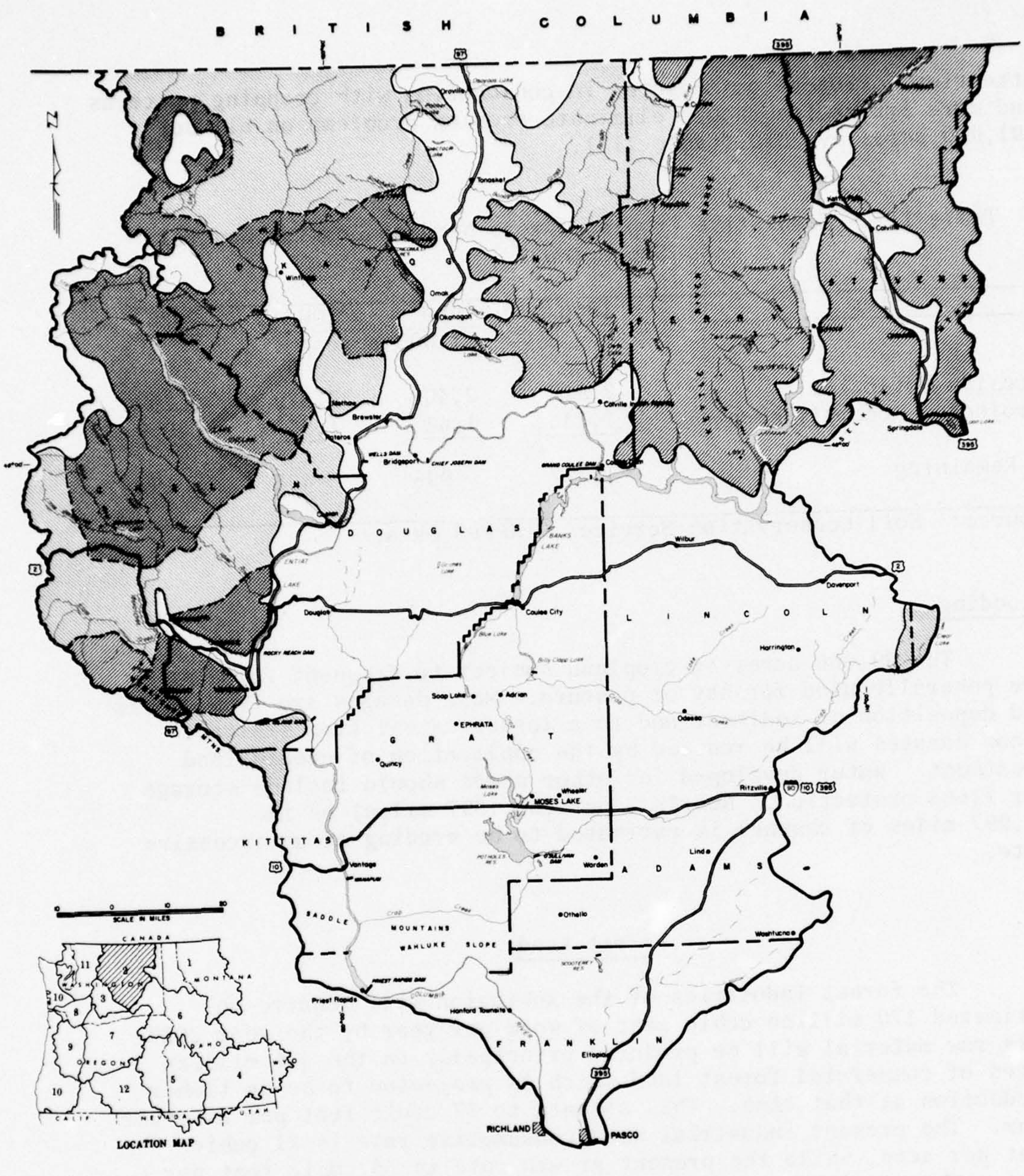
Flooding

The 89,000 acres of cropland subject to frequent flooding are generally used for hay or pasture. Most damages are from debris and deposition of sediment and to a lesser extent from erosion. Flood damages will be reduced by the application of needed land treatment. Water developed for other needs should include storage for flood protection. Nearly 2 percent (397 miles) of the 17,997 miles of channel is estimated to be eroding at an excessive rate.

Forest Land

The forest industries of the subregion will require an estimated 170 million cubic feet of wood per year by the year 2020. This raw material will be produced principally on the 4.6 million acres of commercial forest land which is projected to be in timber production at that time. This amounts to 37 cubic feet per acre per year. The present industrial wood consumptive rate is 21 cubic feet per acre, while the present growth rate is 36 cubic feet per acre. This indicates a healthy situation in which the present industrial wood consumption is well below present growth rates. However, wood production supply requirements (growth) must be increased considerably if 2020 raw material demands are to be realized.

Potential sediment yield and erosion hazard on the forest lands are shown on table 118 and the accompanying map (figure 16). It represents the potential yield prior to land treatment or protection and could exceed present yields by eight times.



LEGEND

- Low Soil Loss
- Medium Soil Loss
- High Soil Loss

COLUMBIA–NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

POTENTIAL EROSION HAZARD
FOREST LAND

UPPER COLUMBIA, SUBREGION 2

1968

FIGURE 16

USDA-SCS-PORTLAND, OREG. 1969

Table 118 - Potential Sediment Yield Without Protective Measures, Forest Land, Subregion 2

Soil Loss Category	Acres (1,000)	Percent	Acre-feet per Square Mile per Year	Total Acre-feet
Low	2,147.9	38	Less than 0.2	336
Medium	1,808.7	32	0.2 - 1.5	565
High	1,695.5	30	More than 1.5	3,974
Total	5,652.1	100		4,875

Source: Soil Survey Data & Interpretations, Forest Service, Regions 1 and 6.

Watershed Protection

In order to meet the future wood fiber requirements, the existing harvest program will need to be intensified. The ultimate road system will need early completion so that all salvable or over-mature timber will be accessible. This salvage program is a necessary part of expanded timber production operations. Table 119 lists the cumulative future timber harvest, road construction, and land treatment programs resulting from this acceleration.

Table 119 - Projected Cumulative Timber Harvest Activity, Forest Land, Subregion 2

	Unit	1980	2000	2020
Timber Harvest Area	Ac.	804,000	1,868,000	2,915,000
Road Construction	Mi.	4,800	11,200	17,500
Ground Disturbance 1/	Ac.	169,000	392,000	612,000

1/ Includes both harvest area requiring protection and road mileage, converted to acres, requiring cut and fill treatment.
Source: Based on the 1965 level of timber requirements.

This table indicates that by the year 2020, over 600,000 acres of forest land will have had the ground severely disturbed by logging and road construction. This is the area, that if not properly treated, has the highest sediment yield potential.

With nearly 3 million acres coming under harvest by 2020, better management by the public agencies for the public lands and increased technical assistance for the private is mandatory.

Watershed Rehabilitation

Future demands for water supplies for irrigation, municipal supplies, and recreation purposes will require improved water quality through reduced sediment levels and maintained or reduced stream water temperatures.

Watershed rehabilitation work is still required on much of the forest land in the subregion. Work should first be concentrated on the areas of high and medium sediment yields where problems are most critical (table 107). These areas have severely damaged vegetative cover; and rehabilitation work, such as the reestablishment of grass, trees, and other restoration work, would be most effective.

Water Yield Improvement

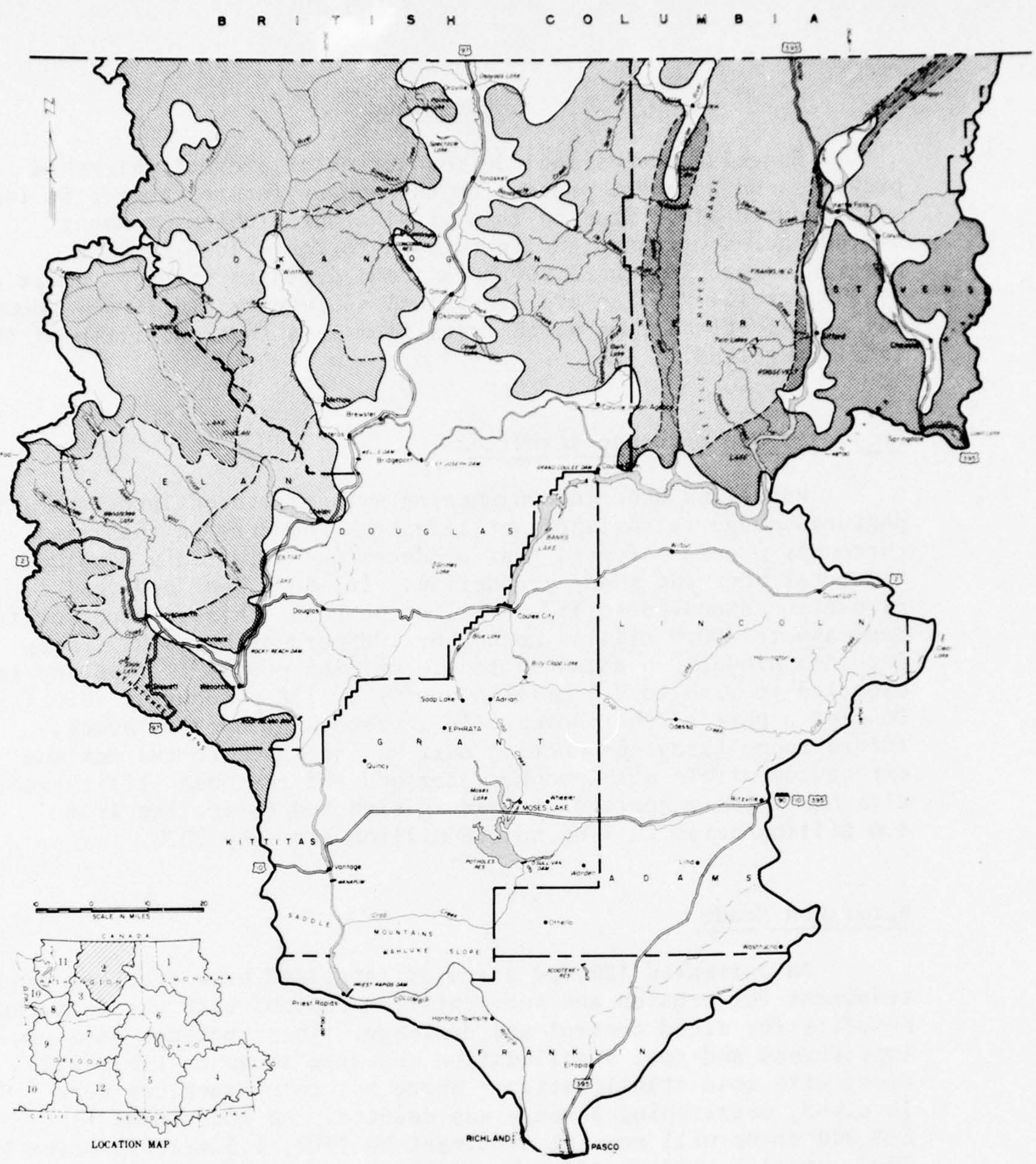
Since over 90 percent of the runoff originates here, one of the most important roles of the subregion's forest land is the furnishing of optimum streamflows. Through adjustments in the forest canopy and snowpack management, these yields may be improved appreciably.

The water retention capacity for the forest soils is shown on table 120 and figure 17. Soils in the high storage class have water storage capacity of 6,000,000 acre-feet, almost equal to the total annual runoff from these areas. Water yield improvement practices on these soils would improve infiltration, increase the ground-water recharge, and assist in reducing overland flood flows.

Table 120 - Water Retention Capacity, Forest Soils, Subregion 2

Retention Class	Acres (1,000)	Percent	Acre-feet per Square Mile	Total Acre-feet
Low	2,599.8	46	Less than 300	1,219,000
Medium	2,091.6	37	300 - 1,500	2,941,000
High	960.7	17	More than 1,500	6,000,000
Total	5,652.1	100		10,160,000

Source: Soil Survey Data & Interpretations, Forest Service, Regions 1 and 6.



LEGEND

LOW	LESS THAN 300 AC. FT. PER SQ. MI. PER YEAR
MEDIUM	300-1,500 AC. FT. PER SQ. MI. PER YEAR
HIGH	MORE THAN 1,500 AC. FT. PER SQ. MI. PER YEAR

COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

WATER RETENTION CAPACITY FOREST LAND

UPPER COLUMBIA, SUBREGION 2

1968

FIGURE 17

USDA-SCS PORTLAND, OREG. 1969

Rangeland

Rangeland needs include resolution of present watershed problems and adequate protection throughout future changes in land and resource use. Erosion is a significant problem on about 447,400 acres of rangeland in this subregion; flooding is a particular problem on 22,000 acres; and drainage problems exist on 19,300 acres.(3) The average annual sediment yield is now about 709 acre-feet, half of which comes from less than one-fifth of the total rangeland.

Projected Use of Range Resources

Rangeland used in conjunction with irrigated lands and farm pastures supports an important livestock industry in this area. It currently provides forage that produces an estimated 9.4 percent of the total beef and sheep production. In 1964, beef and veal production amounted to 117.7 million pounds. This is expected to increase to 350.9 million pounds or 198 percent by 2020. Sheep and lamb production amounted to 4.0 million pounds in 1964 and is expected to rise to 9.5 million pounds or 138 percent by 2020.(3) To meet a part of the increase in livestock production needs, future range forage production must be increased to the maximum extent compatible with proper watershed and resource utilization, although total rangeland acreage is expected to decline from 4.6 million acres in 1966 to 4.3 million acres by 2020.

Watershed Needs

An estimated 109,700 acres of rangeland have received land treatment for erosion and sedimentation control with accompanying benefits for flood control and drainage. This includes most cover improvement and soil stabilization measures shown on table 112 along with road stabilization. Where multiple practices were involved, overlapping acreage was deleted. An additional 388,000 acres will require treatment by 1980, 1.3 million acres by 2000, and 1.7 million acres by 2020. A number of small water control structures are needed to assure adequate erosion and sediment control.

Protection and management practices have been applied on some 1.1 million acres of rangeland by 1966, including reduction or adjustment of excessive livestock grazing use to the grazing capacity of the range, and special fire control practices where required. Other management practices for improved livestock distribution and control included development of livestock and game water facilities and construction of control fences. These protection and management practices should be extended to an

additional 751,000 acres by 1980, 1.3 million acres by 2000, and 2.0 million acres by 2020.

By 1966, an estimated 75 miles of streams and waterways in rangeland areas had been improved by stream clearance, channel improvement, or efforts for improved water quality. An additional 30 miles need attention by 1980, 205 miles by 2000, and 255 miles by 2020.

Some 25 miles of bank stabilization work have been accomplished in rangeland areas. This includes the stream and bank stabilization acreages reported in the "Present Status" section with conversion to miles on the basis of 40 acres per mile. Future needs include an additional 443 miles of bank stabilization along streams and reservoirs by 1980, 1,208 miles by 2000, and 1,293 miles by 2020.

Other Land

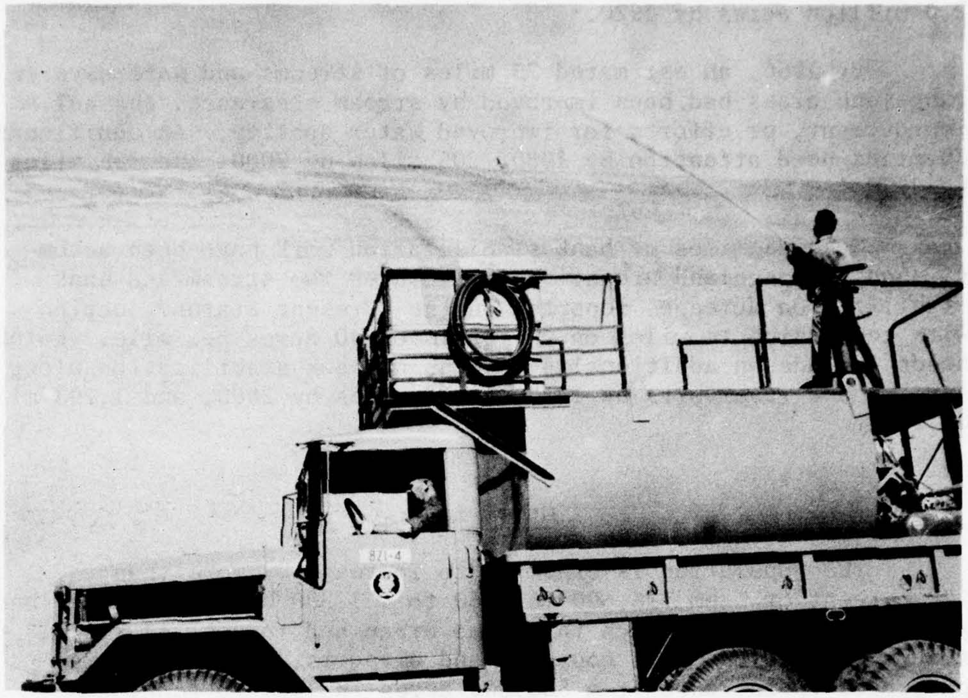
The population is expected to increase by more than 120 percent or from 193,600 in 1960 to 431,300 by 2020. More land will be required for such things as urban and industrial sites, road construction, golf courses, and airports. Other land is projected to increase from 536,000 acres in 1966 to about 662,000 acres in 2020. The demand, from people living outside the subregion, for waterfront home sites and view properties should more than triple.

More efficient water management practices are required in the irrigation of lands in urban and suburban areas and along roadsides, which are expected to increase from 22,000 acres to an estimated 54,000 acres by 2020.

Water requirements for municipal supplies, industrial uses, irrigation, and rural domestic uses will grow proportionately to population. Facilities to handle sanitary disposal of wastes will also parallel population growth. Information and interpretation of soils properties to determine their usefulness as foundations and septic drain fields will be needed for planning urban and industrial sites, as well as lakeside developments.

Flood prevention is required to protect about 3,600 acres now subject to flooding, and zoning is needed to prevent developments in these areas. Erosion control measures are needed to reduce sediment originating on other and adjacent lands.

Considerably more study is required of areas in the other land category to properly identify and present future needs.



The application of surface mulch protects new highway construction until newly seeded grasses become established. (SCS W-3256-2)

MEANS TO SATISFY NEEDS

A combination of improved management practices, land treatment measures, and water control structures will be necessary to satisfy future watershed needs. Many of these requirements will be in upper watershed areas to protect or improve downstream watershed conditions.

Frequently the most effective means to satisfy land treatment needs is to apply practices by cooperative efforts of the landowners. Of 108 watersheds in the subregion, 103 have been identified as having a complexity of problems which will require coordinated planning and development efforts. These are listed on table 121 by type of watershed problem and by time period. Location of these areas is shown on figure 18.

Table 121 - Practices Required for Cooperative Conservation Development
Subregion 2

Target Date	No. of Water-sheds	Flood Preven-tion	Erosion Control	Drainage	Irrigation New	Irrigation Supple-ment	Land Treat-ment
		(1,000 acres, w/number of watersheds in parentheses)					
1980		35.8	349.4	3.2	119.5	9.2	352.6
	(10)	(9)	(10)	(3)	(5)	(2)	(10)
2000		22.4	232.0	11.9	276.2	5.7	243.8
	(28)	(25)	(21)	(8)	(25)	(8)	(28)
2020		54.3	888.0	34.6	1,309.9	22.4	922.6
	(65)	(36)	(44)	(19)	(51)	(19)	(52)
Total		112.5	1,469.4	49.7	1,705.6	37.3	1,519.0
Total No. of Watersheds	(103)	(70)	(75)	(30)	(81)	(29)	(90)

Source: Soil Conservation Service, C-NPRBS Data.

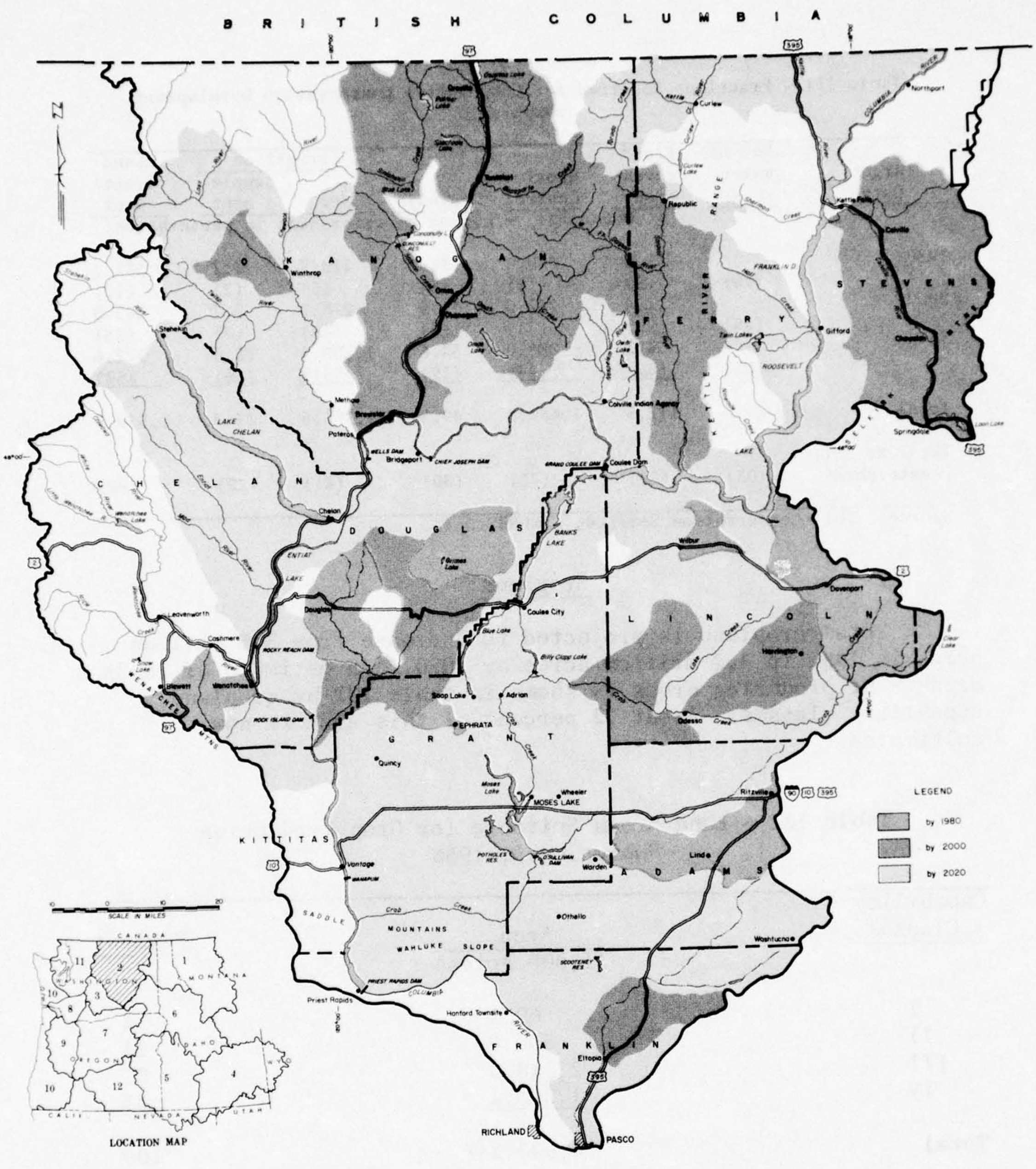
Cropland

Total cropland is projected to increase from 3.3 million acres in 1966 to 4.2 million acres by 2020. An estimate of lands capable of producing crops is shown in table 122 by cropland capability classes. About 72 percent of this area is now cultivated.

Table 122 - Land Areas Suitable for Crop Production
Subregion 2, 1966

Capability Class1/	Area (1,000 Acres)	Percent
I	69.1	1
II	500.0	11
III	2,518.0	55
IV	1,503.1	33
Total	4,590.22/	100

1/ Defined in the Glossary.
2/ About 200,000 acres of Class VI land are also arable when irrigated.
Source: Appendix IV, Land and Mineral Resources.



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

AREAS NEEDING COOPERATIVE WATERSHED DEVELOPMENT

UPPER COLUMBIA, SUBREGION 2

1968

FIGURE 18

Acreage yields of some crops grown in this area are the highest in the nation and are expected to increase. Yields will be enhanced by proper irrigation, adequate drainage, and increased protection from flooding and erosion.

Water Conservation

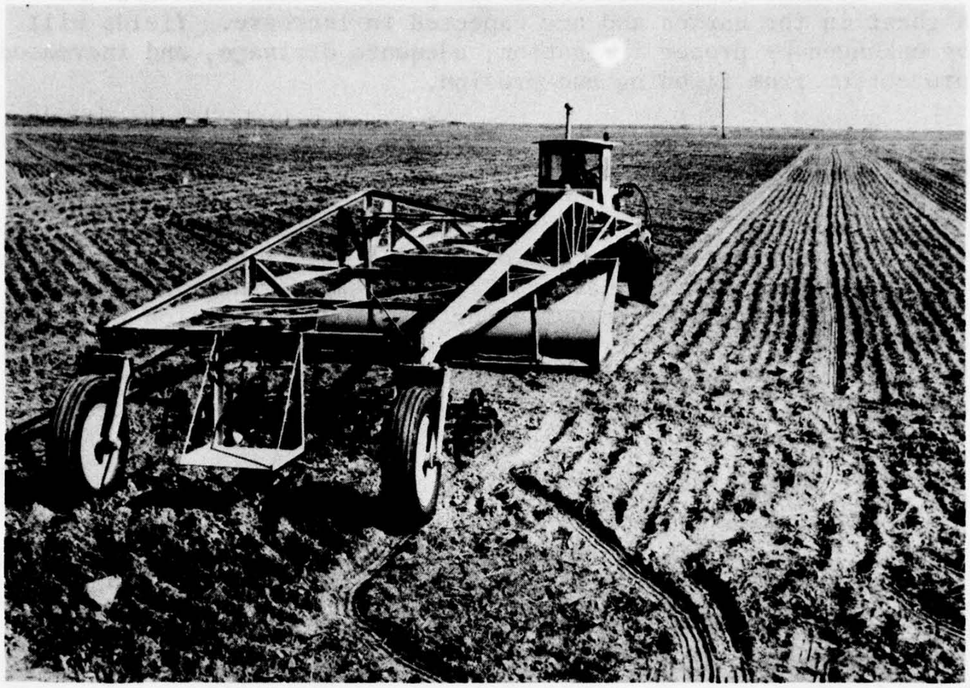
The Columbia Basin has an excellent potential for expansion of fruit and vegetable production. Crops requiring a large per acre capital investment must have soils with good drainage and nearly level land. Sprinklers provide for efficient irrigation and climate modification. Surface irrigation systems should also be improved. Projected practices for more efficient use of irrigation water or an expanded irrigation acreage are shown in table 123.

Table 123 - Cumulative Projected Practices for Irrigated Cropland
Subregion 2

Practice	Units	1966	1980	2000	2020
Water Control Facilities	No.	10,534	13,836	20,430	27,051
Irrigation Water Conveyance	Miles	2,575	3,382	4,994	8,027
Water Storage	No.	110	118	134	150
Irrigation System, Surface	No.	1,812	1,810	1,150	600
Irrigation System, Sprinkler	No.	6,274	8,240	12,168	16,111
Land Shaping	1000 Acs.	152	200	295	390
Irrigation Water Mgt.	1000 Acs.	160	350	620	1,090

Source: Soil Conservation Service, C-NPRBS Data.

Eighteen Water Storage sites have been identified, having a total storage capacity of 23,700 acre-feet (an average of 1,300 acre-feet per site). Detailed studies are needed to locate additional water storage sites for flood protection, irrigation, municipal and industrial supplies, recreation, and pollution reduction.



Land planing to a uniform grade gives a more even penetration of irrigation water. Spring harrow roughens land after planing to prevent wind erosion. (SCS W-1125-1)

Drainage

By 2020, drainage practices should be applied on about 116,100 acres, including areas presently drained, to meet projected cropland requirements. Future drainage practices are shown on table 124.

Table 124 - Cumulative Practices Required to Provide Needed Drainage, Subregion 2

Practice	Unit	1966	1980	2000	2020
Conduits & Ditches	Miles	914	1,200	1,773	2,347 1/
Structures	No.	254	334	493	793

1/ There are 8,100 miles in addition not shown because they are presented and costed with irrigation on the Columbia Basin Project.

Source: Soil Conservation Service, C-NPRBS Data.

The increase in total wet acres is attributed to an increase in the area to be irrigated. Although, improved irrigation efficiencies will tend to reduce the wetness problem of some soils. Some of the drainage already installed has been only enough for moisture-tolerant grasses. A higher degree of drainage will be installed on the better soils to grow a greater variety of crops.

Erosion and Sedimentation

Of the land now in cultivation, 2.5 million acres have been classified with erosion as the major use limitation. Nearly 1.3 million acres need additional treatment to control erosion. Cropping systems will generally handle this problem in irrigated areas, while special treatment on sandy soils, used for growing annual crops, will be required. Erosion control practices needed to attain erosion objectives are shown in table 125.

Table 125 - Cumulative Practices to Satisfy Erosion Control Needs, Subregion 2

Practice	Unit	1966	1980	2000	2020
Grade Stab. Structures	No.	402	528	780	1,174
Diversions & Terraces	Miles	49	64	95	126
Ditch Bank Seeding	Miles	10	13	19	26
Field Windbreak	Miles	233	306	452	598
Crop Residue Use	1000 Acs.	1,239	1,769	2,403	3,182
Stubble Mulch	1000 Acs.	633	831	1,228	1,626
Grassed Waterway	1000 Acs.	3	4	6	8
Stripcropping	1000 Acs.	16	21	31	41
Cons.Cropping System	1000 Acs.	1,488	1,954	2,886	3,821
Pasture & Hayland Planting	1000 Acs.	134	176	260	344

Source: Soil Conservation Service, C-NPRBS Data.

Vegetative cover in orchards provides protection against wind and water erosion. Clear cultivation around trees aids in rodent control. (SCS W-1907-8)

These listed practices lessen the impact of rain and reduce the velocity of runoff water from cropland. Structures are placed to reduce the length of field slope and divert the water from the field at a nonerosive velocity. The proper placing of practices will also reduce wind erosion.

Terraces and contour farming increases water penetration, reduces erosion, and controls runoff. (SCS W-3971-2)

Flooding

Flood protection will be provided in conjunction with the development of water for irrigation and other uses. Stream channels will receive varying degrees of work. Table 126 shows the projected stream channel and diking measures that are necessary to reduce local flooding.

Table 126 - Cumulative Cropland Flood Prevention Practices, Subregion 2

Practice	Unit	1966	1980	2000	2020
Stream Channel Imp.	Miles	180	251	349	462
Stream Channel Stab.	Miles	2	2	3	4
Dikes and Levees	Miles	4	5	7	9
Stream Bank Protection	Miles	48	64	93	123

Source: Soil Conservation Service, C-NPRBS Data.

Program Costs

The cost of implementing conservation practices discussed in the previous sections are given in table 127 and are based on 1969 dollars.

Table 127 - Cumulative Estimated Cost of Cropland Conservation Practices Subregion 2

Item	Water Conservation	Drainage	Erosion Control	Flood Control	Total
			(1,000 dollars)		
1966-1980					
Private Funds	337,087	8,780	159,680	11,260	516,807
Public Funds	39,065	308 2/	19,320	14,543	73,236
Technical Cost 1/	18,807	1,363	16,110	1,079	37,359
Total	394,959	10,451	195,110	26,882	627,402
1981-2000					
Private Funds	725,100	14,368	289,220	15,294	1,043,982
Public Funds	81,317	622 2/	35,000	19,473	136,412
Technical Cost 1/	40,328	2,248	29,180	1,048	72,804
Total	846,745	17,238	353,400	35,815	1,253,198
2001-2020					
Private Funds	1,013,865	16,100	367,100	16,987	1,414,052
Public Funds	112,364	585 2/	44,440	21,542	178,931
Technical Cost 1/	56,311	2,503	37,039	1,386	97,239
Total	1,182,540	19,188	448,579	39,915	1,690,222

1/ Include public and private costs.
2/ Included in the Columbia Basin Project public irrigation costs are $30 million by 1980, another $200 million by 2000, and $70 million between 2001 and 2020. These costs are exchuded from this table to prevent double accounting.
Source: Soil Conservation Service, C-NPRBS Data.

Forest Land

Increasing requirements for the lumber, plywood, wood pulp, and other forest products will place greater demands on the forest resources. This will require increasing levels of watershed protection, reduction in present sediment levels, and increased streamflows. These land treatment requirements, in turn, go hand-in-hand with the structural development program.

Watershed Protection

Increased logging, road construction, and other forest land developments will require higher standards of protection on public and private forest lands. By the year 2020, standards on private lands should be equivalent to those presently utilized on public forest lands. Table 128 outlines the anticipated total cost of such practices, accumulated through the year 2020. These costs are based on the assumption that: (1) On the public forest lands, controls through the timber sale and construction contracts are adequate when properly applied, and (2) on the private forest lands, the minimum required by the year 2020 will be about equal to that presently in force on the public lands.

Table 128 - Projected Costs for Watershed Protection Practices
Forest Land, Subregion 2

Practices	Unit	Total Units1/	Total Cost1/ (1,000 dollars)
PUBLIC FOREST LAND			
Logging Disturbance Treatment	Ac.	284,000	5,680
Harvest Road Treatment2/	Mi.	11,400	2,850
Other Watershed Requirements3/	Ac.	4,511,000	102,130
Total Cost			110,660
PRIVATE FOREST LAND			
Logging Disturbance Treatment	Ac.	154,000	2,310
Harvest Road Treatment	Mi.	6,100	1,220
Other Watershed Requirements	Ac.	1,109,000	39,490
Total Cost			43,020
TOTAL ALL LAND			
Logging Disturbance Treatment	Ac.	438,000	7,990
Harvest Road Treatment	Mi.	17,500	4,070
Other Watershed Requirements	Ac.	5,620,000	141,620
Total Cost			153,680

1/ Total for 55-year period 1965-2020. Costs in 1969 dollars.
2/ Includes road maintenance.
3/ Includes watershed surveys, plans, fire protection, timber cultural practices, and other indirectly related items.

At the rate shown on this table, recurrent watershed protection measures to maintain the productive condition will cost about $2 million annually on the public forest lands and cost $780,000 annually on the private.

Watershed Rehabilitation

The forest lands most in need of rehabilitation are areas in the medium and high sediment yield categories (table 107). These areas produce about 100 acre-feet of sediment per year. Treatment needs and the amount that should be accomplished during time periods 1980, 2000, and 2020 are listed in table 129.

Table 129 - Projected Watershed Rehabilitation Programs, Forest Land, Subregion 2

Program	Unit	1980 Amount	1980 Cost 1/ ($1,000)	2000 Amount	2000 Cost 1/ ($1,000)	2020 Amount	2020 Cost 1/ ($1,000)
PUBLIC LANDS							
Land Treatment	Ac.	63,500	1,166	11,800	1,020	13,300	1,170
Stream Rehabilitation	Mi.	1,030	17,382	625	6,577	990	13,112
Road Rehabilitation	Mi.	925	323	910	168	510	16
Total Cost			18,871		7,765		14,298
PRIVATE LANDS							
Land Treatment	Ac.	3,000	45	4,000	60	3,000	45
Stream Rehabilitation	Mi.	30	15	60	30	70	35
Road Rehabilitation	Mi.	200	6	200	6	100	3
Total Cost			66		96		83
TOTAL ALL LANDS							
Land Treatment	Ac.	66,500	1,211	15,800	1,080	16,300	1,215
Stream Rehabilitation	Mi.	1,060	17,397	685	6,607	1,060	13,147
Road Rehabilitation	Mi.	1,125	329	1,110	174	610	19
Total Cost			18,937		7,861		14,381

1/ In 1969 dollars.

The expected sediment reduction accomplished by these measures is 19 percent or slightly over 100 acre-feet per year, primarily by treatment of lands now in the medium yield category (table 130).

Table 130 - Expected Annual Sediment Reduction
Forest Land Rehabilitation, Subregion 2

Present Yields 1/	Acres (1,000)	Total Sed. Yield Acre-feet/Year	Acres Treated 2/	Sed. Reduction Acre-feet/Year
Very Low	3,113.1	97	--	--
Low	2,225.3	348	91,000	11.4
Medium	302.7	95	303,000	85.1
High	11.0	8	11,000	6.8
Very High	--	--	--	--
Total	5,652.1	548		103.3
			Total reduction, percent	19

1/ Data from table 107.
2/ Data from table 129. Miles treated converted to acres.

In addition to the needs for sediment reduction on the presently eroding forest lands, nonrecurrent work will be required on future burned-over areas, other natural disasters, and lands directly related to planned water development projects. These problems will be treated as they occur. Therefore, the 19 percent sediment reduction is that amount possible, excluding new sources from major fire or other natural cause.

Water Yield Improvement

Water yield program opportunities are listed in table 131, along with the amount that should be accomplished during time periods 1980, 2000, and 2020. Timber harvest on the private forest lands is modified principallv to meet silivicultural requirements. Therefore, neither water yield improvement practices nor benefits are estimated for the private sector, although some benefit undoubtedly does occur.

Table 131 - Projected Water Yield Improvement Practices,
Public Forest Land, Subregion 2

Program	Unit	1980 Amount	1980 Cost 1/ ($1,000)	2000 Amount	2000 Cost 1/ ($1,000)	2020 Amount	2020 Cost 1/ ($1,000)
Cover Manipulation 2/	Ac.	10,000	750	37,000	1,575	40,500	1,238
Snowpack Management	Mi.	5	250	7	350	8	400
Water Spreading 3/	Ac.	5,600	126	12,000	218	7,000	168
Total Cost			1,126		2,143		1,806

1/ In 1969 dollars.
2/ Includes type conversion and riparian vegetation management.
3/ Planned for altering timing of runoff or ground-water recharge, not irrigation or other resource activity.

Total Program Costs

The total estimated cost of forest watershed protection and land treatment programs through the year 2020 is summarized below:

	Costs ($1,000)
Watershed Protection	153,680
Watershed Rehabilitation	41,179
Water Yield Improvement	5,075
Total	199,934

Rangeland

Measures and Practices for Watershed Protection

Land treatment and management practices to satisfy needs for rangeland watershed protection, rehabilitation, and improvement are presented in tables 132, 133, and 134. Most of these practices which improve watershed conditions also have other management objectives or purposes. A combined total of 3.5 million acres of

Table 132 - Required Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, 1966 to 1980, Subregion 2

Measures and Practices	Units	Land Ownership			Watershed Purposes 1/			
		Public 2/	Private	Total	(1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	61,400	104,200	165,600	-	x	x	x
Brush Control	Acres	31,600	53,700	85,300	-	x	x	x
Weed Control	Acres	42,900	72,800	115,700	-	x	x	x
Fertilizing	Acres	41,500	70,400	111,900	-	x	x	-
Contouring, Pitting, Furrowing	Acres	80,100	135,900	216,000	x	x	x	-
Deep Tillage	Acres	5,000	8,500	13,500	x	x	x	-
Stream & Bank Stabilization	Acres	6,600	11,100	17,700	-	-	x	x
Waterspreading	Acres	19,900	33,800	53,700	-	x	x	-
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	1,800	3,100	4,900	-	x	x	-
Reducing Excessive Grazing Use	Acres	240,800	408,500	649,300	-	x	x	x
Livestock & Game Water Facilities	Number	1,100	1,900	3,000	-	x	x	x
Special Fire Control	Acres	75,600	128,300	203,900	-	x	x	x
Road Stabilization								
Existing Roads	Miles	100	200	300	x	x	x	x
New Roads	Miles	400	700	1,100	x	x	x	x
Stream Clearance	Miles	5	10	15	x	-	x	x
Pollution Abatement	Miles	5	10	15	-	-	x	-
Water Control Structures								
Ponds & Small Reservoirs	Number	60	100	160	x	x	x	x
	Acre Ft.	200	300	500	x	x	x	x
Detentions	Number	60	100	160	x	x	x	x
	Cu. Yds.	2,500	4,200	6,700	x	x	x	x
Check Dams (Gully Plugs)	Number	320	530	850	-	-	x	x
	Cu. Yds.	6,400	10,900	17,300	-	-	x	x
Dikes	Lin. Ft.	1,000	1,600	2,600	x	-	-	x
Diversions	Number	20	30	50	x	x	x	x
	Cu. Yds.	22,000	37,300	59,300	x	x	x	x

1/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4-Flood & Debris Control.
2/ Includes Federal, State, County, and Municipal Ownership.
Source: Data collected from land management agencies specifically for the C-NP Study.

Table 133 - Required Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, 1981 to 2000, Subregion 2

Measures & Practices	Units	Land Ownership Public 2/	Private	Total	Watershed Purposes 1/ (1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	298,900	507,300	806,200	-	x	x	x
Brush Control	Acres	100,900	171,200	272,100	-	x	x	x
Weed Control	Acres	165,900	281,500	447,400	-	x	x	x
Fertilizing	Acres	49,600	84,200	133,800	-	x	x	-
Contouring, Pitting, Furrowing	Acres	45,100	76,500	121,600	x	x	x	-
Deep Tillage	Acres	5,000	8,500	13,500	x	x	x	-
Stream & Bank Stabilization	Acres	11,300	19,300	30,600	-	-	x	x
Waterspreading	Acres	20,000	33,900	53,900	-	x	x	-
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	4,700	8,000	12,700	-	x	x	-
Reducing Excessive Grazing Use	Acres	134,200	227,800	362,000	-	x	x	x
Livestock & Game Water Facilities	Number	2,300	3,900	6,200	-	x	x	x
Special Fire Control	Acres	126,000	213,900	339,900	-	x	x	x
Road Stabilization								
Existing Roads	Miles	200	300	500	x	x	x	x
New Roads	Miles	200	400	600	x	x	x	x
Stream Clearance	Miles	10	15	25	x	-	x	x
Pollution Abatement	Miles	75	100	175	-	-	x	-
Water Control Structures								
Ponds & Small Reservoirs	Number	100	150	250	x	x	x	x
	Acre Ft.	400	700	1,100	x	x	x	x
Detentions	Number	100	175	275	x	x	x	x
	Cu. Yds.	10,000	17,000	27,000	x	x	x	x
Check Dams (Gully Plugs)	Number	500	800	1,300	-	-	x	x
	Cu. Yds.	29,000	49,200	78,200	-	-	x	x
Dikes	Lin.Ft.	2,000	3,400	5,400	x	-	-	x
Diversions	Number	20	40	60	x	x	x	x
	Cu. Yds.	13,000	22,000	35,000	x	x	x	x

1/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4-Flood & Debris Control.
2/ Includes Federal, State, County, and Local Ownership.
Source: Data collected from land management agencies specifically for the C-NP Study.

cover improvement and soil stabilization practices are required between 1966 and 2020. A combination of practices will be needed on some of the same areas, and some practices will be recurrent. About 1.2 million acres will need revegetation work, including an estimated reseeding of 61,000 acres. About 45 percent of these efforts will be for watershed purposes and 55 percent for range forage production. Some 525,000 acres will require brush eradication and replacement of more useful, protective, and erosion resistant vegetation; weed control practices should be applied on an estimated 717,000 acres; and 1,300 miles of banks along streams or reservoirs should be stabilized by revegetation and other structural measures.

More watershed and soil surveys must be made for comprehensive watershed management. An estimated 1.4 million acres of rangeland now have soil surveys, and an additional 2.7 million acres should be mapped by 2020. To update previous work and to measure management results, more intensive surveys will be required on approximately 1.6 million acres. By 2020, watershed plans should cover about 2.4 million acres of rangeland in this subregion.

Table 134 - Required Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, 2001 to 2020, Subregion 2

Measures & Practices	Units	Land Ownership Public[2]	Land Ownership Private	Land Ownership Total	Watershed Purposes[1] (1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	93,500	158,600	252,100	-	x	x	x
Brush Control	Acres	62,100	105,500	167,600	-	x	x	x
Weed Control	Acres	56,900	96,600	153,500	-	x	x	x
Fertilizing	Acres	60,500	102,700	163,200	-	x	x	-
Contouring, Pitting, Furrowing	Acres	100	200	300	x	x	x	-
Deep Tillage	Acres	5,000	8,500	13,500	x	x	x	-
Stream & Bank Stabilization	Acres	1,300	2,100	3,400	-	-	x	x
Waterspreading	Acres	20,000	33,900	53,900	-	x	x	-
Watershed Oriented Land Management ..actices								
Livestock Control Fences	Miles	3,600	6,200	9,800	-	x	x	-
Reducing Excessive Grazing Use	Acres	220,600	374,300	594,900	-	x	x	x
Livestock & Game Water Facilities	Number	2,600	4,500	7,100	-	x	x	x
Special Fire Control	Acres	108,700	184,500	293,200	-	x	x	x
Road Stabilization								
Existing Roads	Miles	300	500	800	x	x	x	x
Pollution Abatement	Miles	20	30	50	-	-	x	-
Water Control Structures								
Ponds & Small Reservoirs	Number	100	200	300	x	x	x	x
	Acre Ft.	400	700	1,100	x	x	x	x
Detentions	Number	100	175	275	x	x	x	x
	Cu. Yds.	10,000	17,000	27,000	x	x	x	x
Check Dams (Gully Plugs)	Number	600	1,000	1,600	x	x	x	x
	Cu. Yds.	39,000	66,200	105,200	x	x	x	x
Dikes	Lin. Ft.	2,000	3,400	5,400	x	-	-	x
Diversions	Number	75	100	175	x	x	x	x
	Cu. Yds.	17,000	28,800	45,800	x	x	x	x

1/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4-Flood & Debris Control.

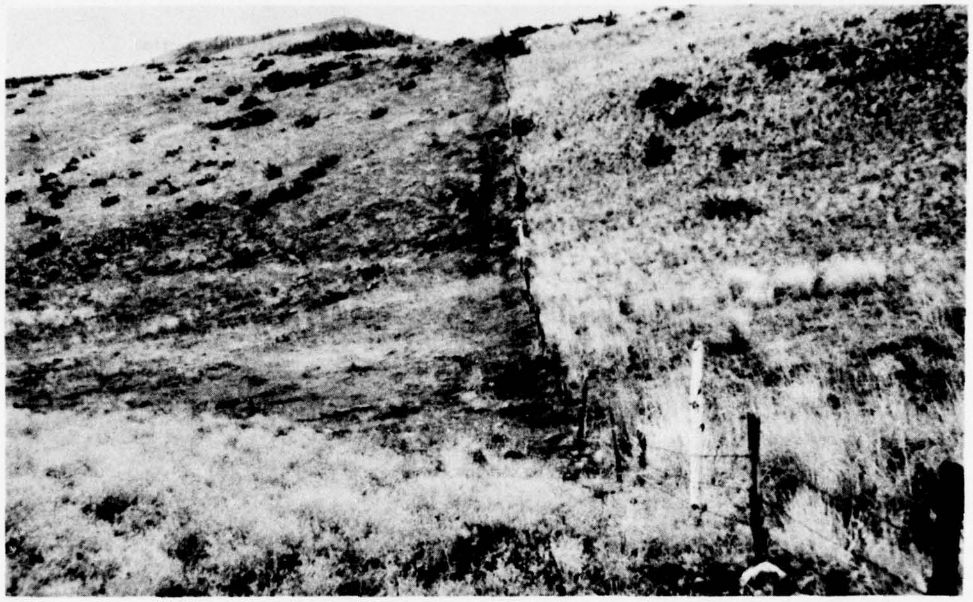
2/ Includes Federal, State, County, and Municipal Ownership.

Source: Data collected from land management agencies specifically for the C-NP Study.

Between 1966 and 2020, livestock use should be adjusted or restricted on some 1.6 million acres to prevent further damage to the watershed, rehabilitate deteriorated areas, or to allow an increased utilization by big game. Improved livestock distribution and control will require construction of about 27,400 miles of livestock fence and development of 16,300 livestock and game water facilities.

More fire protection is necessary and some fire protection agencies need additional financial resources to permit early suppression action while fires are still small. Special fire prevention efforts will be required on about 837,000 acres, including extra fire patrol, fire breaks, and the development of facilities for fire control water supply.

On about 1,650 miles of existing roads and 1,700 miles of new roads, stabilization practices are necessary to minimize erosion and sedimentation and prevent excessive runoff. Stream clearance is needed along some 40 miles of waterways, including removal of debris, vegetation, and gravel bars from water courses to allow natural streamflow; and pollution abatement measures will be required along about 240 miles of rangeland streams. (Much of this will be recurrent attention to previously treated areas.)



On this Methow Valley range, vegetative cover to the left of the fence has been depleted by overgrazing. To the right, proper management has resulted in good vegetative cover for watershed protection and forage for livestock and big game. (SCS W-3856-6)

Required water control structures between 1966 and 2020 include about 700 ponds and small reservoirs with a total storage capacity of some 2,700 acre-feet, 700 detention dams, about 3,700 small check dams, 3 miles of dikes, and 285 diversion dams to allow water spreading in additional areas.

Erosion and Sediment Yield Improvement

Rangeland areas most in need of rehabilitation in terms of sediment reduction are in the "High," "Medium," and "Low" sediment yield categories (shown on table 111) which account for only 18 percent of the total range acreage but contribute about 359 acre-feet annually or 51 percent of the total sediment load. The measures shown on tables 132, 133, and 134 for erosion and water quality control should be concentrated on these areas. Reduction or redistribution of grazing use on some areas and improved vegetative cover should result in a reduction of approximately 34 percent of the annual sediment yield from 709 acre-feet in 1966 to 468 acre-feet in 2020. (table 135)

Table 135 - Annual Sediment Yield Projections from Rangeland, Subregion 2

Sediment Yield Categories[1/]	1966	1980	2000	2020
		Rangeland Acreage (1,000 acres)		
Very Low	3,734.0	3,591.9	3,652.3	3,880.4
Low	402.5	439.4	532.7	401.6
Medium	428.2	317.6	168.0	18.0
High	19.2	14.1	7.0	-
Very High	-	-	-	-
Total	4,583.9	4,363.0	4,360.0	4,300.0
Percent Change from 1966	.0	-4.8	-4.9	-6.2
		Annual Sediment Yield (acre-feet)		
Very Low	350	337	342	364
Low	95	103	125	94
Medium	234	173	92	10
High	30	22	11	-
Very High	-	-	-	-
Total	709	635	570	468
Percent Change from 1966	0	-10	-20	-34

1/ Very Low through Very High categories represent generalized range areas on which annual sediment yield per square mile averages .06, .15, .35, 1.00, and 2.75 acre-feet respectively.

Improved Range Condition and Capacity

Estimated future range improvement, shown on table 136, will result in part from accomplishment of required measures and practices listed in tables 132, 133, and 134, and in part from other management practices to improve forage production. In 1966 only 25 percent of the total rangeland was in good condition. With scheduled improvements, good condition range will be increased to 79 percent by 2020, or from 1.2 million acres to 3.4 million acres. Poor condition range, which in 1966 accounted for 41 percent of the total, will be decreased to 9 percent by 2020 (from 1.9 million acres to 363,000 acres). Major rehabilitation efforts will be directed to poor condition rangeland.

Table 136 - Estimated Potential Rangeland Improvement, Subregion 2

Range Type and Condition	1966 Acres (1,000)	1966 AUM's (1,000)	1980 Acres (1,000)	1980 AUM's (1,000)	2000 Acres (1,000)	2000 AUM's (1,000)	2020 Acres (1,000)	2020 AUM's (1,000)
Grassland								
Good	699.6	194.3	861.7	239.4	1,112.8	309.1	1,410.7	391.8
Fair	1,028.6	122.5	839.4	99.9	635.2	75.6	332.9	39.6
Poor	1,179.9	84.3	961.3	68.7	398.8	28.5	215.2	15.4
Seeded Range	117.3	39.1	269.2	89.7	1,035.8	345.3	1,258.1	419.4
Total	3,025.4	440.2	2,931.6	497.7	3,182.6	758.5	3,216.9	866.2
Sagebrush								
Good	309.4	51.6	379.0	63.2	561.7	93.6	656.1	109.4
Fair	443.9	34.1	366.2	28.2	207.1	16.0	112.2	8.6
Poor	591.8	23.7	483.1	19.3	205.6	8.2	114.6	4.6
Total	1,345.1	109.4	1,228.3	110.7	974.4	117.8	882.9	122.6
Other Brush								
Good	49.1	12.3	56.8	14.2	73.2	18.3	91.3	22.8
Fair	70.4	7.0	65.9	6.6	77.5	7.7	75.4	7.5
Poor	93.9	4.1	80.4	3.5	52.3	2.3	33.5	1.5
Total	213.4	23.4	203.1	24.3	203.0	28.3	200.2	31.8
Total								
Good1/	1,175.4	297.3	1,566.7	406.5	2,783.5	766.3	3,416.2	943.4
Fair	1,542.9	163.6	1,271.5	134.7	919.8	99.3	520.5	55.7
Poor	1,865.6	112.1	1,524.8	91.5	656.7	39.0	363.3	21.5
Grand Total	4,583.9	573.0	4,363.0	632.7	4,360.0	904.6	4,300.0	1,020.6
Average AC/AUM	8.0		6.9		4.8		4.2	
Percent Increase from 1966	.0	.0	-4.8	+10.4	-4.9	+57.9	-6.2	+78.1

1/ Includes seeded range.
Source: Table 124 - "Present Status" rangeland narrative. Estimates for this study are based on representative on-site surveys for production guides with consideration to the capability of the range for improvement with proper management and utilization.

With an improved condition and 6 percent decline in total rangeland acreage by 2020, the 1966 capacity of 573,000 AUMs is expected to increase to 1.0 million AUMs in 2020, an increase of 78 percent. Even with this significant improvement, range forage production will meet only about 5.7 percent of the anticipated demand for livestock production in Subregion 2 by 2020 compared to 9.4 percent in 1966.

Estimated Program Investment Costs

Investment cost estimates (based on 1969 dollars) are given in table 137 for all future measures and practices shown on tables 132, 133, and 134. Cover improvement and soil stabilization programs will require $41 million between 1966 and 2020, or 78 percent of the total rangeland watershed costs of $52.4 million. Watershed oriented land management costs require $10.6 million or 20 percent of total program costs, and water control structures require $800,000 or 2 percent of the total costs.

Based on the present ratio of land ownership, an estimated $33.1 million will be needed for privately owned rangeland (63 percent of total costs). The public range will require $19.3 million or 37 percent of all needs.

Table 137 - Estimated Cost of Required Measures and Practices for Watershed Protection and Rehabilitation of Rangeland by Major Types of Watershed Programs, Subregion 2 1/

Major Types of Watershed Programs	1966 to 1980 ($1000)	1980 to 2000 ($1000)	2000 to 2020 ($1000)	Total ($1000)
		Public		
Cover Improvement and Soil Stabilization	5,567.2	7,885.1	1,632.2	15,084.5
Watershed Oriented Land Management Practices	869.1	1,661.8	1,376.6	3,907.5
Water Control Structures	61.6	115.3	119.5	296.4
Total	6,497.9	9,662.2	3,128.3	19,288.4
		Private		
Cover Improvement and Soil Stabilization	9,381.6	13,771.1	2,702.7	25,855.4
Watershed Oriented Land Management Practices	1,507.2	2,826.6	2,367.3	6,701.1
Water Control Structures	102.6	178.3	229.5	510.4
Total	10,991.4	16,776.0	5,299.5	33,066.9
		Total		
Cover Improvement and Soil Stabilization	14,948.8	21,656.2	4,334.9	40,939.9
Watershed Oriented Land Management Practices	2,376.3	4,488.4	3,743.9	10,608.6
Water Control Structures	164.2	293.6	349.0	806.8
Total	17,489.3	26,438.2	8,427.8	52,355.3

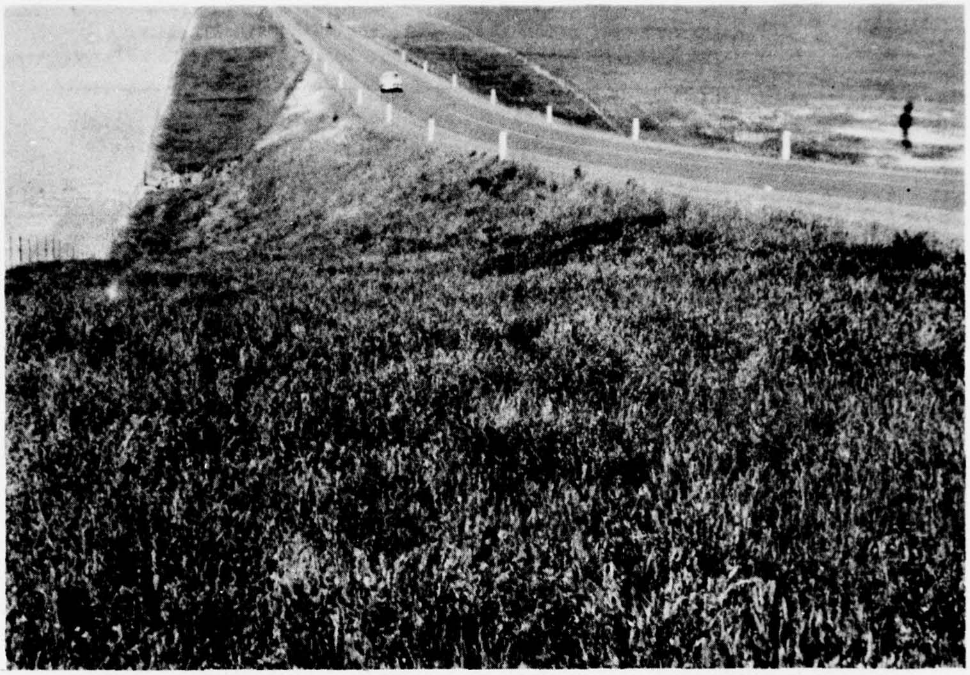
1/ Based on measures and practices shown on tables 132, 133, and 134 with constant 1969 dollars.

Other Land

Joint planning by all levels of government and private interests must be accomplished to meet watershed needs in this period of expanding subregional development. Planning should provide for flood protection, drainage, water needs, recreation, fish and wildlife, and esthetic values. Urban needs and planning must be closely coordinated with developments in the agricultural industry, particularly those on lands adjoining urban and suburban areas.

The 59 watersheds with water supply problems for municipal, industrial, and rural domestic uses need more intensive study to determine the extent of the problem and feasible solutions. Adequate sewage treatment is lacking in a number of these areas. Future investigations should include a determination of possible sources of water to meet requirements for these communities.

Channel work, flood water retention structures, or a combination of the two will be required to reduce flood damage on



Erosion along major highways is controlled by a good vegetative cover. (SCS RO-578-8)

the 3,600 acres of urban land that are subject to frequent flooding. In addition, flood plain zoning is needed to keep this problem from growing.

Intensive soil surveys and interpretations are needed in areas of future urban expansion to assist in planning. Soil interpretations should include considerations on drainage, flooding, and sliding, as well as soil suitability for foundations and septic drain fields. Soil areas not suited to urban development should be zoned until the problem is solved.

Orderly disposal of surface water, both from the area and waterways through the area, is an essential part of urban growth. Development plans include adequate facilities for disposal of this water.

Erosion from adjacent land and construction sites is a continuing and increasing problem in urban and industrial areas. Measures to control this problem will include land treatment on adjacent lands, more adequate floodways, debris basins, and strict controls on construction sites to prevent sediments and debris from leaving the site.

An estimated 72,300 acres of dune stabilization work should be accomplished between 1966 and 2020. This includes planting or seeding of some areas to reestablish vegetative cover and other structural or vegetative measures to prevent expansion of active dunes.

Most measures and practices required to satisfy needs for other land have been included and costed in other sections of this appendix and in Appendices VII, Flood Control; IX, Irrigation; XI, Municipal and Industrial Water Supply; and XII, Water Quality and Pollution Control.

SUBREGION 3
YAKIMA

PRESENT STATUS

The Yakima Subregion has a total area of nearly 3.9 million acres (2 percent of the Columbia-North Pacific Region). This includes more than 3.8 million acres of land and 29,000 acres of large water areas. About 62 percent of the land in the subregion is publicly owned and 38 percent is private. Generalized cover and land use for the subregion is shown on figure 19a and table 138.

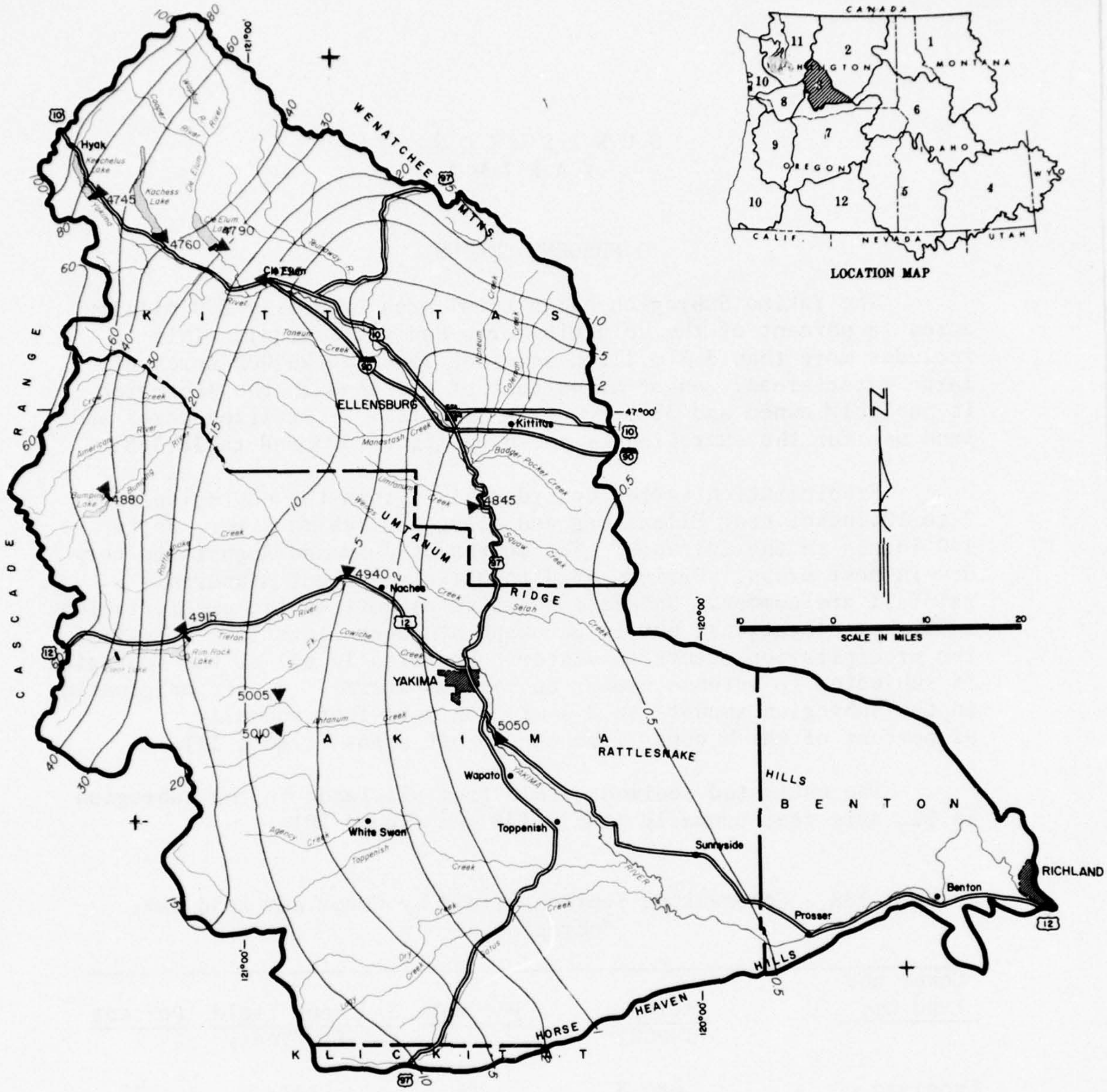
Precipitation varies considerably within the subregion from 7 to 10 inches near Ellensburg and along the Yakima River, up to 140 inches in the Cascades. The months of July and August are very dry in most areas. Periods of 4 to 6 weeks without measurable rainfall are common. Snowfall constitutes most of the precipitation in higher elevations, but is uncommon at lower elevations. Most of the precipitation occurs in winter. Practically all of the subregion is subjected to intense summer convection storms. Runoff originating in the subregion amounts to 2.3 million acre-feet annually, 92 percent of which comes from the forest areas (figure 19).

The estimated sediment yield from all lands in the subregion is 522 acre-feet annually (table 138 and figure 20).

Table 138 - Generalized Sediment Yield by Cover and Land Use, Subregion 3

Cover and Land Use	Acres (1,000)	Percent	Sediment Yield (Ac-Ft./Year)	Percent
Cropland	686.3	18	141	27
Forest Land	1,508.9	39	202	39
Rangeland	1,534.8	40	158	30
Other Land	121.4	3	21	4
Total	3,851.4	100	522	100

Source: Derived from figures 19a and 20 and Appendix IV, Land and Minerals.



Explanation

▲ 3960 STREAM GAGE - RECORDING

Notes

(1) MEAN ANNUAL RUNOFF ISOPLETHS FOR NATURAL FLOW CONDITIONS WERE DERIVED USING OBSERVED STREAM FLOWS, CLIMATOLOGICAL DATA, DEPLETIONS, AND PHYSIOGRAPHIC FEATURES OF THE BASIN FOR THE PERIOD 1931-1960.

(2) STREAM GAGING STATIONS SHOWN ARE SELECTED STATIONS AND ARE NOT THE ONLY STATIONS USED IN PREPARING THE RUNOFF MAP.

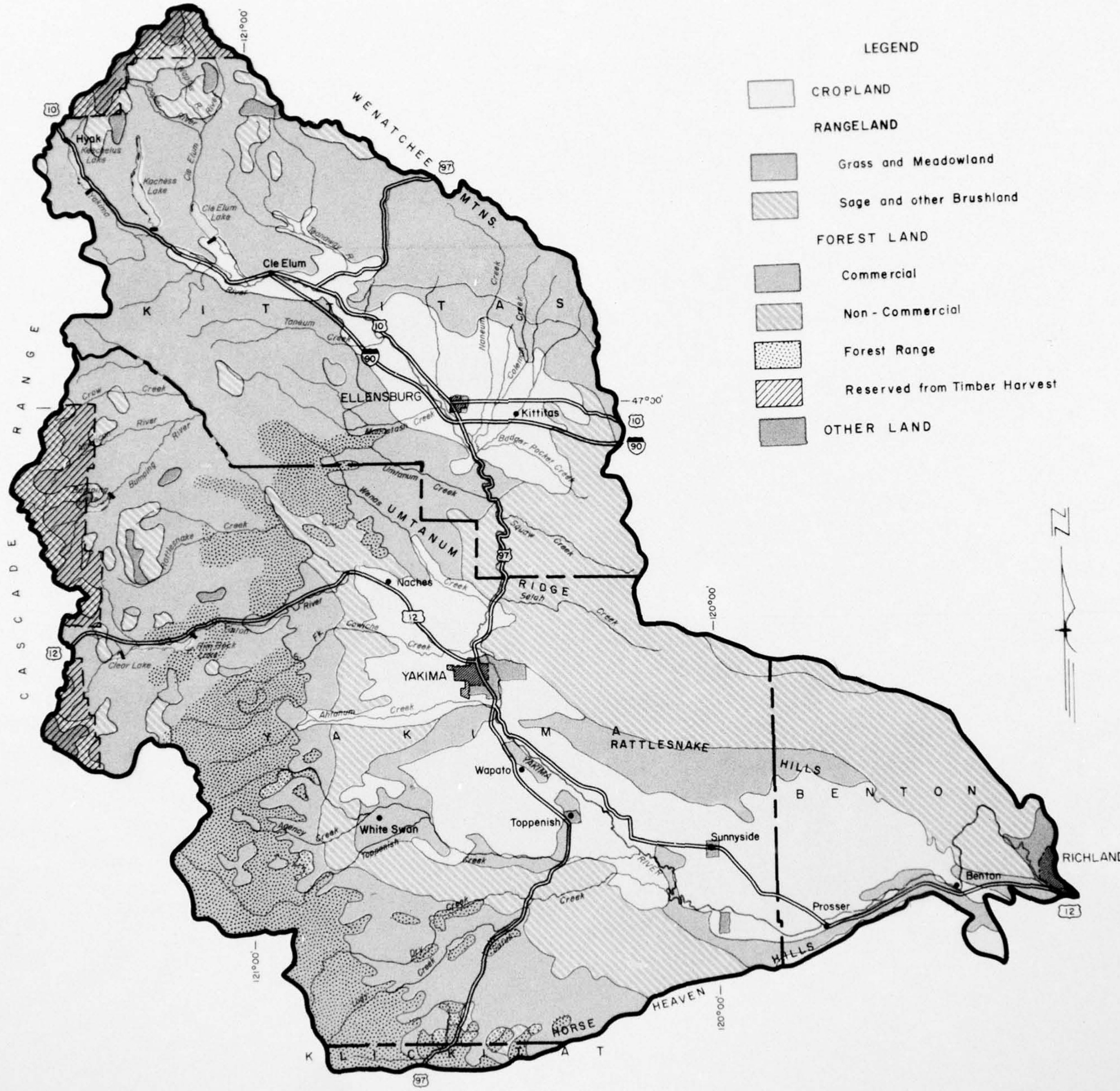
COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

MEAN ANNUAL RUNOFF IN INCHES

YAKIMA SUBREGION 3

1968

FIGURE 19


LEGEND
CROPLAND
RANGELAND
Grass and Meadowland
Sage and other Brushland
FOREST LAND
Commercial
Non - Commercial
Forest Range
Reserved from Timber Harvest
OTHER LAND
N
WENATCHEE MTNS.
K I T T I T A S
CASCADE RANGE
Y A K I M A
K L I C K I T A T
B E N T O N
UMTANUM RIDGE
RATTLESNAKE HILLS
HORSE HEAVEN HILLS
Hyak
Kachess Lake
Cle Elum Lake
Cle Elum
ELLENSBURG
Kittitas
Naches
YAKIMA
Wapato
Toppenish
White Swan
Sunnyside
Prosser
Benton
RICHLAND
Clear Lake
121°00'
120°00'
47°00'

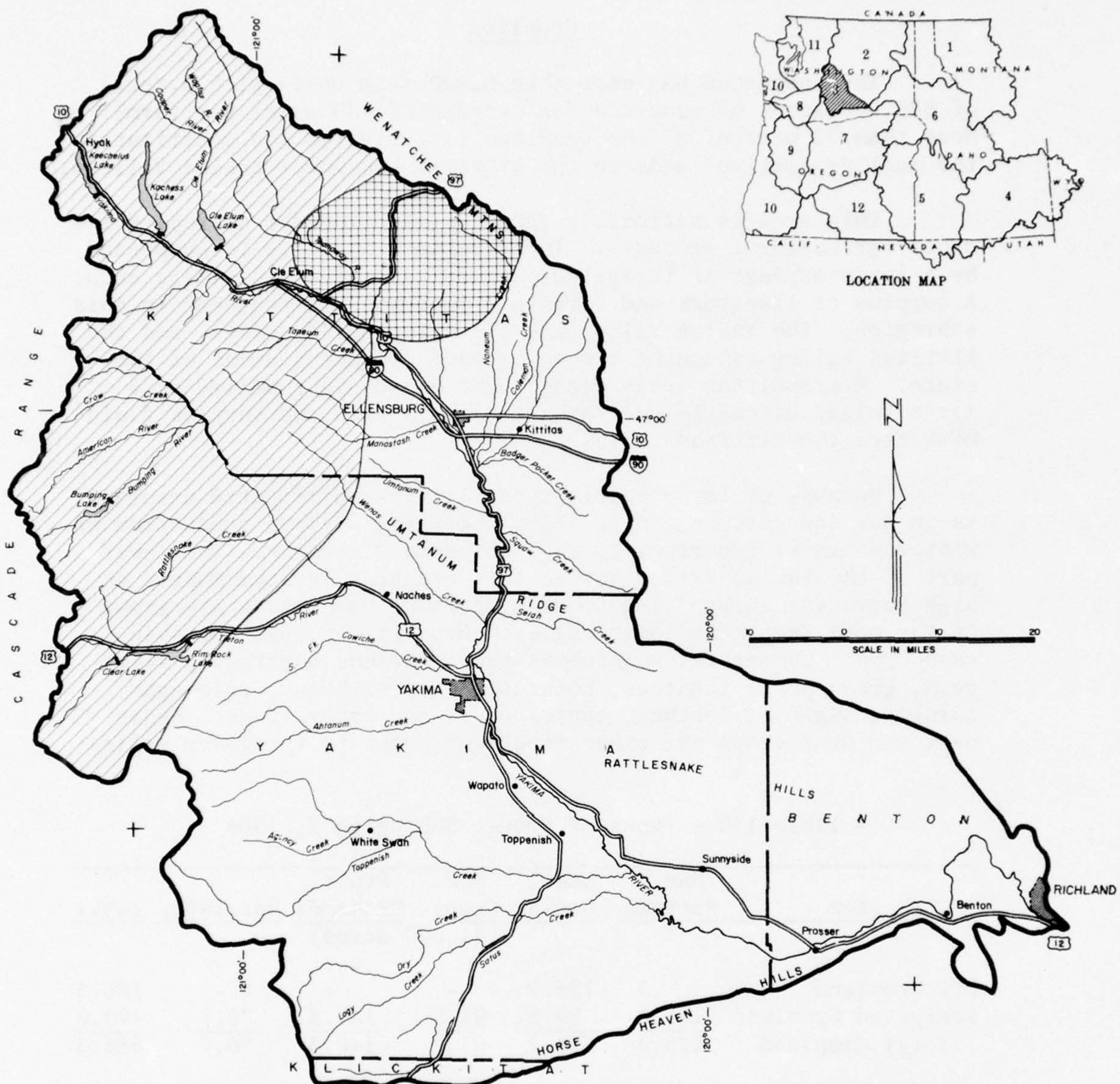
LOCATION MAP

COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY
GENERALIZED COVER AND LAND USE
YAKIMA, SUBREGION 3
1968

USDA-SCS-PORTLAND, OREG. 1970

FIGURE 19a

2



EXPLANATION

Yield in acre-feet per square mile per year

- 0.02 - 0.1
- 0.1 - 0.2
- 0.2 - 0.5
- 0.5 - 1.5
- 1.5 - 4.0

2,780 Highest observed concentration in mg/l

COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

GENERALIZED SEDIMENT YIELD

YAKIMA SUBREGION 3

1968

FIGURE 20

Cropland

The subregion has more than 6,800 farm units with a total of 686,000 acres of cropland (an average of 100 acres per farm). More than 71 percent of the cropland is irrigated and constitutes the most productive lands in the Kittitas and lower Yakima Valleys.

This area is nationally famous as an exporter of apples and other agricultural products. The livestock industry is supported by a large acreage of irrigated pasture, alfalfa, and silage corn. A surplus of livestock and livestock products are produced in this subregion. The Yakima Valley has the principal feedlots, and the Kittitas Valley is one of the major beef producing areas of the state. Metropolitan areas along Puget Sound are supplied by a large volume of cattle and lambs from this area and surplus fluid milk from the Kittitas Valley.

Because of low precipitation, little nonirrigated cropland is in hay and pasture (table 139). However, dryland production of winter wheat is important to the subregion's economy. The lower part of the Yakima Valley has apricot orchards located mostly on high terraces. Grapes and other high value cash crops are grown in the more temperate lower valley. Hops is the most valuable cash crop. Commercial vegetables grown include asparagus, sweet corn, green peas, tomatoes, potatoes, onions, beans, rutabagas, turnips, carrots, lettuce, cantaloupes, and watermelons. Sugar beet and mint crops are other important crops in the lower valley.

Table 139 - Types of Crops, Subregion 3, 1966

Item	Hay & Pasture	Small Grain	Row Crops	Fruit Orchards	Specialty	Total
			(1,000 acres)			
Dry Cropland	.3	196.0	-	-	-	196.3
Irrigated Cropland	116.0	59.2	91.8	146.3	76.7	490.0
Total Cropland	116.3	255.2	91.8	146.3	76.7	686.3

Source: Appendix IV, Land and Mineral Resources.

Water Conservation

Water is the major limiting factor to crop production in the subregion. Irrigation is necessary to produce most crops, except dryland grains, and is essential to produce all crops where the precipitation is less than 7 or 8 inches. Thus, irrigation is the major use of water resources and most available sources have already been preempted for this purpose.

Industrial growth of the area is adding to the competition for the water resources. As population increases, there will be a greater demand for water for recreation, municipal and industrial use, and pollution abatement, as well as for agriculture. Thus, water yield, quality, and seasonal availability of water are of prime importance in the area.

Such land treatment measures as stubble mulching, strip-cropping, contour tillage, and subsoiling, when applied on dryland, will result in conservation of water (table 140). Many of these measures have been adopted by farmers as standard farming practices.

Table 140 - Water Conservation Practices Applied on Cropland, Subregion 3, 1966

Practice	Units	Total
Water Control Facilities	No.	7,879
Irrigation Water Conveyance Facilities	Miles	5,936
Water Storage Facilities	No.	112
Irrigation System, Surface, and Subsurface	No.	3,900
Irrigation System, Sprinkler	No.	1,800
Land Shaping	1,000 Acres	156
Irrigation Water Management	1,000 Acres	176

Source: Soil Conservation Service Data.

Many uses of water complement each other. For example, the impoundment of small bodies of water for livestock may serve other purposes such as: recreation, fishing, wildlife development, fire control, improved ground-water supply, and storage to reduce flooding, erosion, and sedimentation.

The major irrigated areas are the Kittitas Valley around Cle Elum and Ellensburg and the upper and lower Yakima Valley (table 141). Surface water presently provides 96 percent of the irrigation needs for the subregion. There is frequently a shortage of water on the smaller tributaries to the Yakima River. Transmission losses and over-irrigation aggravate water shortages, drainage, erosion, and alkali salt accumulation problems. Because most of the streamflow is derived from snowmelt, streams have more than ample flow early in the season, but decrease during the growing season.

Table 141 - Water Availability and Irrigation Methods for Cropland
Subregion 3, 1966

Item	Acres (1,000)	Percent
Water Source		
Streamflow	261.6	53
Ground Water	17.4	4
Reservoir Storage	211.0	43
Total	490.0	100
Area with adequate supply	387.0	79
Area with inadequate supply	103.0	21
Method of Application		
Sprinkler	100.0	20
Flooding	390.0	80

Source: Soil Conservation Service, C-NPRBS Data.

The method and efficiency of applying irrigation water vary throughout the subregion, ranging from the efficient pipeline and sprinkler system to a single farm diversion from a creek or river using uncontrolled flooding. The Kittitas Valley has 46 irrigation organizations, while the Yakima Valley has 116 irrigation organizations. Irrigation districts supply water to about 434,000 acres of the Yakima Subregion.

The Census of Agriculture 1959, Volume III, reports 494,305 acre-feet of water entered the irrigation distribution system above Umtanum; of this, the system lost 13 percent (65,629 acre-feet). There is an additional 7 percent loss from the water entering the irrigation conveyance system between Union Gap and Umtanum. Judging from the return flow to the Yakima River, it is assumed that many of the smaller distribution systems have a much higher transmission loss than these quoted from the Agricultural Census.

Drainage

Many drainage problems have resulted from installing irrigation systems and not providing suitable drainage to dispose of surplus water. In addition to soil wetness and ponding, this has contributed to alkali and salt accumulation. Proper irrigation is normally needed to prevent further accumulations of alkali and salt, and excessive irrigation may be used to wash out some of the accumulated alkali and reduce salt concentration. Many soil areas in this subregion have lime-cemented hardpans at moderate to shallow depths. Surplus irrigation water running laterally above such a pan

becomes saturated with salts; and, on reaching low lying areas, evaporates and deposits salt on the surface. Suitable drainage must intercept this ground water as well as dispose of ponded or wet areas in lower lying places. Thus, drainage has two purposes: to remove free water from the soil profile, and to keep salt accumulations below the toxic level of crops. The soils are so variable that each wet area needs investigation to determine the source of water and the best drainage procedure.

There are 113,000 acres of cropland which are too wet for optimum crop production without drainage practices, as shown in table 142. More than 65 percent of this acreage, or 73,200 acres, has received some degree of drainage to dispose of excess water.

Table 142 - Cropland Areas with a Wetness Problem, Subregion 3, 1966

Capability Class	Area (1,000 acres)
II	41.9
III	41.9
IV	29.7
Total	113.5

Source: Soil Conservation Service, C-NPRBS Data.

Table 143 shows some drainage practices which have been applied to cropland. Installed drainage systems must be maintained to lengthen the growing season and allow a greater diversification of crops.

Table 143 - Drainage Practices Applied to Cropland, Subregion 3, 1966

Practices	Units	Total
Conduits and Ditches	Miles	1,690
Structures	No.	858

Source: Soil Conservation Service Data.

Erosion and Sedimentation

Soil surveys show more than 497,000 acres of soils have a major erosion potential (table 144). About 11,000 acres of cropland in the Yakima Subregion are presently subject to severe water erosion.

Table 144 - Cropland Areas with an Erosion Potential, by Capability Class, Subregion 3, 1966

Capability Class	Total (1,000 acres)
II	97
III	187
IV	213
Total	497

Source: Soil Conservation Service, C-NPRBS Data.

Sedimentation resulting from water erosion, although one of the most serious problems on cropland, can be successfully controlled by applying land treatment measures and improving vegetative cover. Erosion control measures have been extensively used (table 145). Many of the listed practices have to be maintained or repeated year after year in suitable combination to be effective.

Table 145 - Erosion Control Practices Applied on Cropland, Subregion 3, 1966

Practice	Units	Total
Grade Stabilization Structures	No.	9
Diversions and Terraces	Miles	10
Ditch-Bank Seeding	Miles	37
Field Windbreak	Miles	17
Crop Residue Use	1,000 Ac.	209
Stubble Mulch	1,000 Ac.	83
Grassed Waterway	1,000 Ac.	1
Stripcropping	1,000 Ac.	3
Conservation Cropping System	1,000 Ac.	250
Pasture and Hayland Planting	1,000 Ac.	63

Source: Soil Conservation Service Data.

Flooding

Over 73,000 acres of cropland are subject to flooding. The most severe floods usually result from a prolonged rainfall during the winter or early spring and are generally of short duration; however, the extent of flooding and amount of erosion are highly variable. Problems resulting from floods range from soil erosion to sediment deposition on land, ditches, natural channels, and structures and water damage to crops and property. Water quality and fish life are adversely affected by the silt in streams. Spring and winter floods damage crops by washing out roots, seeds, and seedlings. Agricultural land along the main rivers and tributary streams is subject to overflow damage. Damage has been minimized by adjusting cropping patterns to perennial hay and pasture crops. Total average annual flood damages are estimated to be over $1.8 million in Appendix VII, Flood Control. Some work has been done to reduce flood damages. These accomplishments through 1966 are presented in table 146.

Table 146 - Flood Protection Measures Applied on Cropland Areas, Subregion 3, 1966

Practice	Units	Amount (Miles)
Stream Channel Improvements	Miles	123
Streambank Protection	Miles	11
Stream Channel Stabilization	Miles	21
Dikes and Levees	Miles	19

Source: Soil Conservation Service Data.

Stream channel improvement and dikes and levees help keep streams within banks and control flooding. Streambank protection and stream channel stabilization protect channels from scour and erosion. The 1969 National Assessment of Streambank Erosion shows 139 miles of serious streambank erosion in cropland areas and 895 miles of moderate erosion problems.

Forest Land

Forests cover 1.5 million acres and account for 39 percent of the total land area in the subregion. About 74 percent is in public ownership and the remainder is privately owned. This total is 84 percent commercial and 16 percent noncommercial. The commercial area supports almost 30 billion board feet of merchantable timber, 78 percent on public land and 22 percent on private. In 1964, over 380 million board feet of timber were harvested here.

Although only 39 percent of the subregion is forested, more than 90 percent of the runoff originates in this area. It supplies over half of the municipal and industrial water and 2 million acre-feet for irrigation annually.

Forest lands of the subregion are generally in a good condition with an average annual sediment yield of slightly over 200 acre-feet (table 147). This is a third of the sediment load from all lands in the subregion. About one-fourth is in the "very low" category, with sediment resulting primarily from natural erosion. Another two-thirds is in the "low" category, where steeper topography, coupled with land use activities, has accelerated the erosion. The most serious forest sediment yields come from some 118,000 acres in the "medium" category. This is where rehabilitation work is presently concentrated.

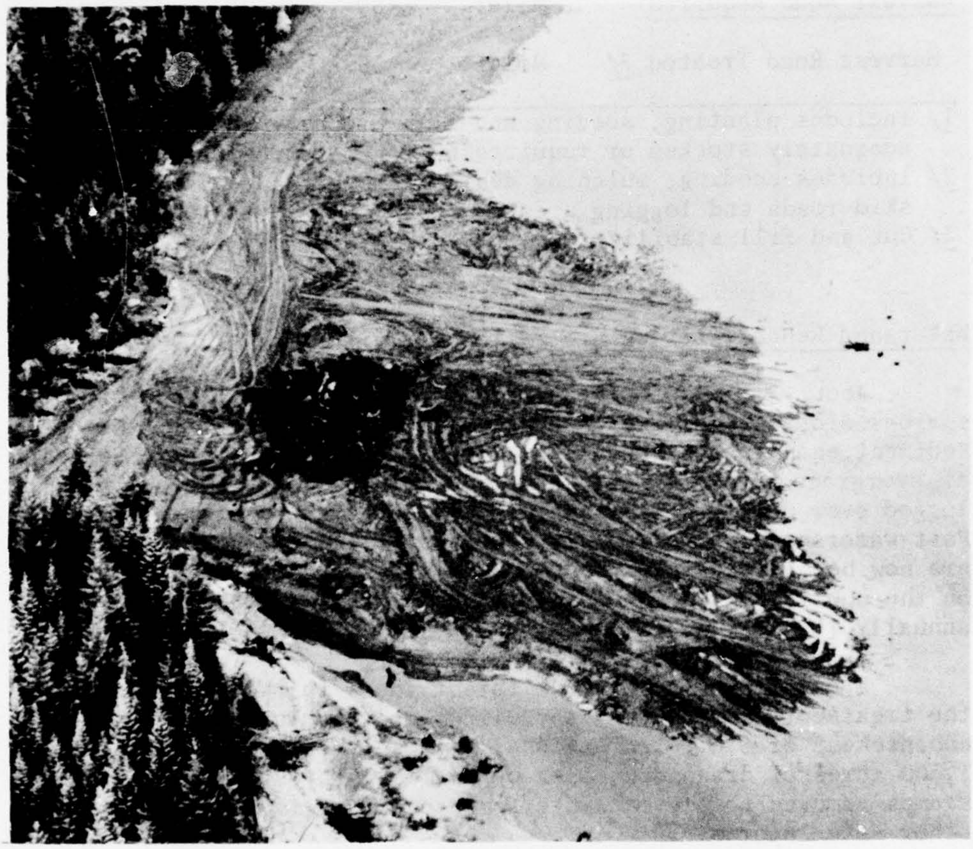
Table 147 - Present Sediment Yield, Forest Land, Subregion 3

Sediment Yield Category	Acres (1,000)	Percent	Annual Sediment Yield: Acre-feet Per Square Mile	Annual Sediment Yield: Total Acre-feet	Annual Sediment Yield: Percent
Very Low	420.4	28	0.02 - 0.1	13	7
Low	970.8	64	0.1 - 0.2	152	75
Medium	117.7	8	0.2 - 0.5	37	18
High	-	-	0.5 - 1.5	-	-
Very High	-	-	1.5 - 4.0	-	-
Total	1,508.9	100		202	100

Source: Derived from figures 19a and 20.

The general timber harvesting method is selective logging of individual or small groups of trees. Logs are removed either by crawler or rubber tired tractors or mobile cable yarders. In some areas, even-aged stands are removed as small, clearcut patches, either with tractors or cable systems.

On the public and Indian lands, tractor trails and temporary roads are generally cross-drained and out-sloped. This spreads out the runoff instead of allowing it to gully the skid roads. Critical areas are seeded to decrease sheet erosion, and logjams are removed from major streams. Most permanent roads are gravel surfaced and have permanent culverts. Where necessary, excavated material is end-hauled to suitable waste areas away from stream bottoms, and exposed cutbank and fill slopes are seeded.



Stump piles, ready for burning, at the proposed Captain Kidd Boat Launching Site on Lake Kachess. (Forest Service)

Reforestation measures include both planting and direct seeding, although many areas restock naturally. Advance reproduction and residual trees in the partial-cut areas are protected from damage by on-the-ground administrative controls. A summary of the timber harvest activities and protection practices are outlined in table 148.

Table 148 - Average Annual Timber Harvest Activity, Subregion 3

	Unit	Public	Private	Total
Harvest Area	Acres	9,000	6,000	15,000
Area Reforested 1/	Acres	1,000	600	1,600
Slash Disposal Area	Acres	4,000	1,200	5,200
Disturbed Area Treated 2/	Acres	1,300	--	1,300
Harvest Road Required	Miles	50	40	90
Harvest Road Treated 3/	Miles	35	--	35

1/ Includes planting, seeding and site preparation. Balance adequately stocked or requires no regeneration work.
2/ Includes seeding, mulching debris removal and cross-draining skid roads and logging areas.
3/ Cut and fill stabilization only.

Watershed Rehabilitation

About 8 percent of the forest land (118,000 acres) has serious erosion problems, producing nearly 20 percent of the sediment each year (table 147). Most of this results from erosion of overgrazed forest range and from water movement across areas logged over during earlier periods in the history of the subregion. Past watershed protection practices were limited, but these areas are now being rehabilitated as rapidly as funds permit. Such work on the public and Indian forest lands affects about 250 acres annually (table 149).

A major program on most forest lands in the subregion is the treatment of reservoir shorelines, particularly for the enhancement of their recreational values. To date, nearly 1,600 acres of drawn down area on national forest lands have had stumps removed to prevent interference with swimming, boating, and other water sports.

Table 149 - Average Annual Accomplishment, Watershed Rehabilitation Practices on Public Forest Land, Subregion 3

Practice	Unit	National Forests1/	B.L.M.2/	Indian Lands	State Lands3/
Sheet Erosion Control	Ac.	160	-	80	-
Gully Stabilization	Mi.	-	-	-	-
Stream Clearance & Stabilization	Mi.	1	-	-	-
Existing Road & Trail Rehabilitation4/	Mi.	-	-	10	2
Reservoir Protection	Ac.	530	-	-	-

1/ Average of period 1964-66.
2/ Minor ownership.
3/ Accomplishment to date principally on active timber sale areas (table 148).
4/ Includes abandoned roads.
Source: Data furnished by agency as listed.

Water Yield Improvement

No water yield improvement programs have been initiated in the subregion. When started, they will be designed to increase late summer flows through cover management and increase snow accumulation by fencing and adjusted cutting patterns.

Rangeland

Subregion 3 has 1.5 million acres of rangeland accounting for 40 percent of the total land area (table 138). About 1.0 million acres (65 percent) is in public ownership, including 832,900 acres of Federal land and 157,600 acres of state land. The Bureau of Indian Affairs administers 433,800 acres of trust lands; 175,100 acres are held by the Department of Defense; and about 224,000 acres are managed by other Federal agencies. Some 544,300 acres or 35 percent are in private ownership (Appendix IV, Land and Mineral Resources).

Range condition and grazing capacity are shown on table 150. Grass is predominant on 50 percent of the rangeland, sagebrush on 46 percent, and other brush and shrubs on 4 percent. The present grazing capacity is about 8 acres per AUM. Rangeland provides important summer forage for breeding stock complementing production of winter feed and forage from irrigated and nonirrigated cropland and pasture. It also provides important browse lands for big game use. Much of the area has been damaged by overgrazing with a decline in both forage productivity and soil stability.

Table 150 - Rangeland Condition and Capacity, Subregion 3, 1966

Range Type and Condition	Ownership: Public Acres (1,000)	Public AUM's (1,000)	Private Acres (1,000)	Private AUM's (1,000)	Total Acres (1,000)	Total AUM's (1,000)
Grassland						
Good	78.8	22.5	72.6	20.8	151.4	43.3
Fair	118.1	14.8	142.8	17.8	260.9	32 6
Poor	125.1	8.3	174.2	11.6	299.3	19.9
Seeded Range 1/	44.2	14.7	11.6	3.9	55.8	18.6
Total	366.2	60.3	401.2	54.1	767.4	114.4
Sagebrush						
Good	140.1	28.0	23.2	4.6	163.3	32.6
Fair	194.7	17.7	39.7	3.6	234.4	21.3
Poor	255.2	13.9	57.3	3.1	312.5	17.0
Total	590.0	59.6	120.2	11.3	710.2	70.9
Other Brush						
Good	7.9	2.0	5.3	1.3	13.2	3.3
Fair	11.3	1.2	7.6	.9	18.9	2.1
Poor	15.1	.7	10.0	.4	25.1	1.1
Total	34.3	3.9	22.9	2.6	57.2	6.5
Total						
Good 2/	271.0	67.2	112.7	30.6	383.7	97.8
Fair	324.1	33.7	190.1	22.3	514.2	56.0
Poor	395.4	22.9	241.5	15.1	636.9	38.0
Grand Total	990.5	123.8	544.3	68.0	1,534.8	191.8
Percent Distribution	64.5	64.5	35.5	35.5	100.0	100.0
Average AC/AUM	8.0		8.0		8.0	

1/ Seeded range acreage was combined with good condition grassland in Appendix IV.
2/ Includes seeded range.
Source: Appendix IV, Subregion 3. Range production has been estimated for the C-NP Study from representative situations observed and recorded in on-site surveys.

Watershed conditions have been improved in recent years; and by 1966, excessive grazing use had been reduced on an estimated 1.2 million acres (79 percent of all rangeland). However, 41 percent of the range was still in poor condition with deficient vegetative cover and unstable soils. Complete recovery will take many years. In the eastern part of the subregion having less than 10 inches of annual precipitation, wind erosion is particularly severe on coarse textured soils which are disturbed or left unprotected. The average annual rangeland sediment yield is 157 acre-feet (table 151), about 30 percent of the yield from all land in the subregion. Although figure 20 shows most rangeland to have an annual yield of 0.1 acre-foot per square mile, small local areas have a higher yield rate, and an estimated 54,000 acres of western foothill range produce up to 0.35 acre-foot per square mile.

Table 151 - Sediment Yield from Rangeland
Subregion 3, 1966

Sediment Yield[1/] Categories	Grassland	Sagebrush & Shrubs	Total	Percent
		Rangeland Acreage (1,000 Acres)		
Very Low	721.9	759.1	1,481.0	97
Low	26.3	8.3	34.6	2
Medium	19.2	--	19.2	1
High	--	--	--	--
Very High	--	--	--	--
Total	767.4	767.4	1,534.8	100
		Annual Sediment Yield (Acre-Feet)		
Very Low	68	71	139	88
Low	6	2	8	5
Medium	10	--	10	7
High	--	--	--	--
Very High	--	--	--	--
Total	84	73	157	100

1/ Very Low through Very High categories represent generalized range areas on which annual sediment yield per square mile averages .06, .15, .35, 1.00, and 2.75 acre-feet, respectively.
Source: Derived from figures 19a and 20.

Measures and Practices for Watershed Protection

Measures accomplished through 1965 are shown on table 152. Many of them serve management objectives other than watershed improvement. Cover improvement and soil stabilization practices have been applied on about 333,000 acres in the subregion. About 15 percent of this work was for erosion and water quality control, 10 percent for water conservation, and 5 percent for flood and debris control.

Considerable progress has been made in adjusting livestock grazing use to the grazing capacity of the range and providing better livestock distribution. Of significance has been the development of grazing management systems providing sufficient rest periods for natural revegetation of range forage cover. The construction of some 600 livestock and game watering facilities and

Table 152 - Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, Subregion 3, 1966

Measures & Practices	Units	Land Ownership: Public2/	Private	Total	Watershed Purposes1/: (1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	44,200	11,600	55,800	-	x	x	x
Brush Control	Acres	56,700	71,600	128,300	-	x	x	-
Weed Control	Acres	93,300	51,400	144,700	-	x	x	x
Fertilizing	Acres	800	500	1,300	-	x	x	-
Stream & Bank Stabilization	Acres	8	4	12	-	-	x	x
Waterspreading	Acres	800	-	800	-	x	-	-
Irrigation	Acres	80	40	120	-	x	-	-
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	700	300	1,000	-	x	x	-
Reducing Excessive Grazing Use	Acres	956,400	259,200	1,215,600	-	x	x	-
Livestock & Game Water Facilities	Number	300	300	600	-	x	-	-
Pollution Abatement	Miles	400	200	600	-	-	x	-
Water Control Structures								
Ponds & Small Reservoirs	Number	70	40	110	-	x	-	-
	Acre Ft.	300	200	500	-	x	-	-
Detentions	Number	10	6	16	-	x	x	x
	Cu. Yds.	1,200	700	1,900	-	x	x	x
Check Dams (Gully Plugs)	Number	8	4	12	-	x	x	x
	Cu. Yds.	500	300	800	-	x	x	x
Dikes	Lin. Ft.	75,500	41,500	117,000	x	x	-	x
Diversions	Number	40	60	100	-	x	-	-
	Cu. Yds.	28,600	41,800	70,400	-	x	-	-

1/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3- Erosion & Water Quality Control; Col. 4-Flood & Debris Control.
2/ Includes Federal, State, County, and Municipal Ownership.
Source: Data collected from land management agencies specifically for the C-NP Study.

about 1,000 miles of livestock fence, have helped improve control of livestock use.

Measures to decrease pollution and improve water quality have been applied to an estimated 600 miles of streams, although most of this has been a recurrent accomplishment along some 60 miles of waterways. These measures included restriction of livestock use directly in streams and water supply sources, provision for sanitary facilities for recreation use near waterways and lakes, and maintenance of shade and cover for protection of fish life.

Other Land

Other land totals 121,400 acres, including 12,900 acres of small water bodies in streams, lakes, and reservoirs; 27,800 acres in roads and railroads; 38,600 acres in urban and industrial developments; 13,400 acres in farmsteads, and 28,700 acres of barren land.

A number of watershed problems have developed, principally on the more intensively used lands, as natural watershed features have been altered and protective vegetative cover disturbed. Deficient quality or quantity of water supplies for municipal, industrial, and rural domestic use is indicated in at least 18 study areas of the subregion. Along with other water requirements,

irrigation water is now being supplied to about 15,000 acres, mostly in urban areas and farmsteads.

An estimated 13,600 acres of urban lands are subject to flood plain flooding. Parts of at least six urban areas are subject to flooding--an average of 1 year in 10. Water damage is not restricted to the flood plain. New farmsteads constructed in areas being developed for irrigation are frequently subject to wet basements and foundations from a rising water table. Subterranean water carried between or above impermeable hardpans often appears some distance away at lower elevations increasing drainage problems on other lands. Water from house tops and pavement increases runoff; concentrates flows; and creates erosion, sedimentation, and drainage problems for low lying areas.

These problems in urban areas have the most adverse effect on adjacent water areas. Sediment decreases the storage capacity of reservoirs, reduces the carrying capacity of canals and streams, and covers fish spawning areas. Pollution from inadequately designed or improperly located septic tanks causes surface and ground-water problems to some communities. Several urban areas provide no more than primary treatment of sewage.

Blowing and drifting sand has created problems in certain parts of the subregion. On an estimated 1,600 acres, stabilization work has been accomplished to prevent expansion of active dunes and to restore vegetative cover in some areas.

FUTURE NEEDS

The population is projected to increase about 95 percent from 227,600 in 1960 to 443,700 in 2020, with an accompanying demand for more urban, recreation, and cropland areas. Cropland acreage is expected to expand by some 82,000 acres; other land (mainly urban), by 52,000 acres; and reservoir areas, by 14,000 acres. These will be offset by an anticipated 107,000-acre decrease in adjacent rangeland and 41,000 acres less in forest areas (table 153). Despite an expanding agricultural industry, the number of people on farms is expected to decrease from 32,600 in 1960 to 15,400 in 2020.

Table 153 - Projected Change in Cover and Land Use, Subregion 3

Item	1966	1980	2000	2020
		(1,000 acres)		
Cropland	686	724	736	768
Forest Land	1,509	1,500	1,490	1,468
Rangeland	1,535	1,486	1,462	1,428
Other Land	121	135	153	173
Total	3,851	3,845	3,841	3,837

Source: Appendix VI, Economic Base and Projections.

Cropland

At the present time, 39,900 acres of cropland need drainage, over 73,200 acres need flood protection, 10,900 acres have erosion problems needing attention, and over 21,500 acres of irrigated land do not have a full season irrigation water supply. These problems limit the safe use of cropland to less than its potential. The projected increase in irrigation (table 154) will require additional cropland treatment.

Table 154 - Projected Trends in Dry and Irrigated Cropland, Subregion 3

Cropland	1966	1980	2000	2020
		(1,000 acres)		
Dry Farmed	196	188	184	178
Irrigated 1/	490	536	552	590
Total	686	724	736	768

1/ Approximately 97 percent of the projections shown in Appendix IX, Irrigation.
Source: Appendix VI, Economic Base and Projections.

Water Conservation

The projected demand for agricultural products will require an increase of about 100,000 acres in irrigated cropland. Water must be developed for these additional needs as well as for the 21,500 acres that are presently short of full season supplies. This will increase the demand for agricultural water supplies by 230,000 acre-feet. The pressing need for more water and the limited supply available will force even greater efficiency in the use and management of this resource. Present efficiency of

approximately 45 percent will be improved by the year 2020. Table 155 shows changes in method of irrigation water application needed to improve efficiency by substantially expanded use of sprinkler systems.

Table 155 - Projected Cumulative Trend in the Method of Irrigation on Cropland, Subregion 3

Item	1966	1980	2000	2020
		(1,000 acres)		
Sprinkler Systems	100	213	352	500
Flood Systems	390	323	200	90
Total	490	536	552	590

Source: Soil Conservation Service, C-NPRBS Data.

Drainage

In the cropland areas, 113,000 acres presently have a drainage problem. Increased production needs and the projected growth in future irrigation are expected to boost drainage needs to 155,000 acres by 2020, an increase of 42,000 acres. Drainage practices should be applied on about 128,000 acres, including areas presently drained, to meet projected cropland requirements (table 156).

Table 156 - Cumulative Cropland Areas Needing Drainage, Subregion 3

Item	1966	1980	2000	2020
		(1,000 acres)		
Wet Areas	113	121	138	155
Projected Accomplishments	73	84	106	128
Remaining	40	37	32	27

Source: Soil Conservation Service, C-NPRBS Data.

The increase in total wet land is attributed to an increase in the area to be irrigated. Improved irrigation efficiencies will reduce the drainage problems on some soils. Some of the installed drainage has only partially met needs, and further treatment would increase yields and adapted crops.

Erosion and Sedimentation

Of the 686,000 acres of cropland in the subregion, 497,000 acres have a major use limitation because of erosion. Nearly 11,000 acres need additional treatment to control erosion under current cropping conditions (table 157).

Table 157 - Cumulative Cropland Areas Needing Erosion Control, Subregion 3

Item	1966	1980	2000	2020
		(1,000 acres)		
Erosion Potential	497	470	435	400
Projected Accomplishments	486	462	430	397
Remaining	11	8	5	3

Source: Soil Conservation Service, C-NPRBS Data.

Flooding

The 87,000 acres of cropland subject to flooding, presently used mostly for hay or pasture, need flood protection to permit more intensive agricultural use. Flood damages, debris, and deposition of sediment are greater than erosion damages and can be reduced by adequate flood control and land treatment.

Water impoundments for irrigation and other uses should include storage to alleviate flooding. Needs exist for treatment of 139 miles of streambank to reduce excessive erosion from flooding.

Forest Land

The forest industries of the subregion will require an estimated 100 million cubic feet of raw material per year by the year 2020. This wood will be produced principally on the 1.2 million acres of commercial forest land projected to remain in production by the year 2020. This amounts to 81 cubic feet per acre per year, which is double the present consumptive rate. The principal problem is the loss of the forest land base to non-productive forest uses. Imports will not solve the problem, as most neighboring subregions will be experiencing similar increases in raw material needs. Improved utilization, thinnings, fertilization, and other management tools must be employed to bring production up to this requirement.

Potential sediment yield and erosion hazard are shown on table 158 and figure 21. It represents potential sediment yields prior to land treatment or protection and could raise present yields over six times.

Table 158 - Potential Sediment Yield without Protective Measures, Forest Land, Subregion 3

Soil Loss Category	Acres (1,000)	Percent	Acre-feet per Square Mile per Year	Total Acre feet per Year
Low	633.6	42	Less than 0.2	99
Medium	453.0	30	0.2 - 1.5	142
High	422.3	28	More than 1.5	990
Total	1,508.9	100		1,231

Source: Soil Survey Data and Interpretations, Forest Service, Region 6.

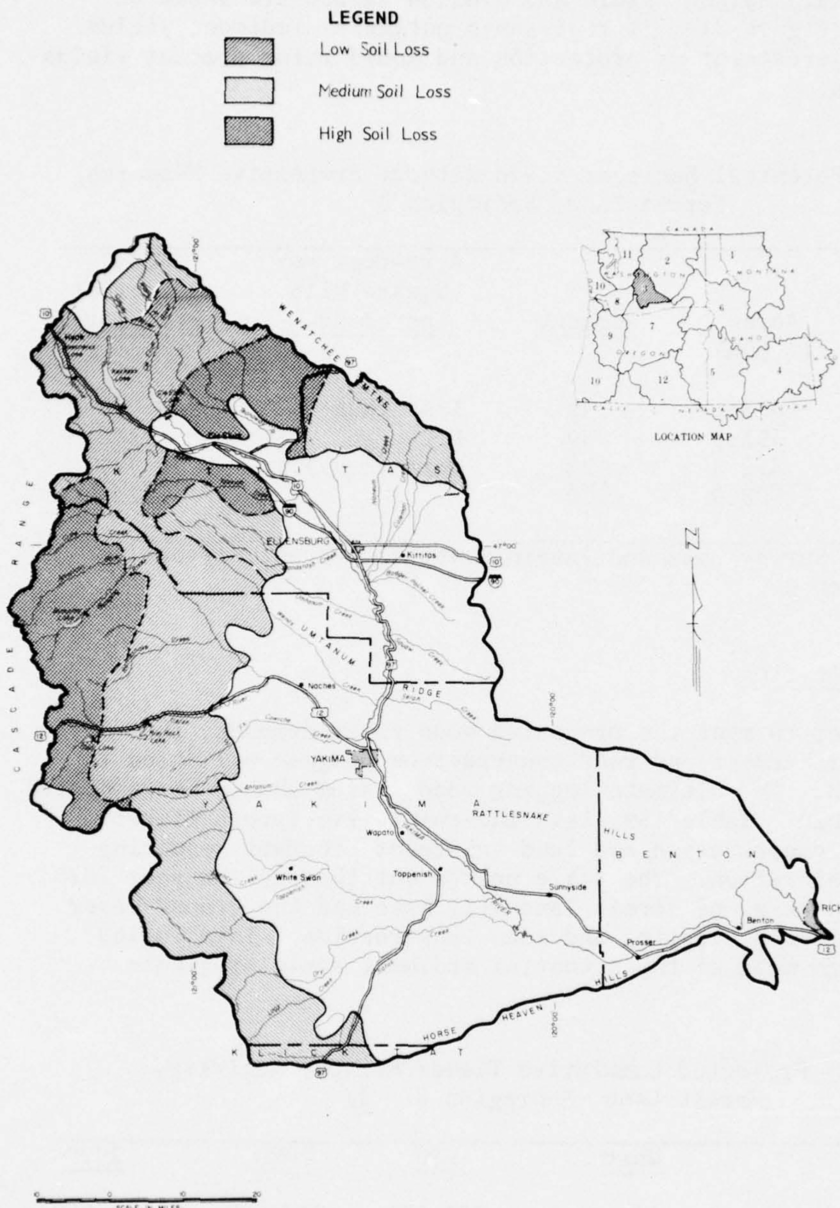
Watershed Protection

In order to meet the projected wood fiber demands, the present timber harvest and road construction program will need to be accelerated. The ultimate logging road system should be completed by the year 2020. Table 159 lists the cumulative future timber harvest, road construction, and land treatment programs resulting from this acceleration. The table points out that by the year 2020, nearly 180,000 acres of forest land will have had the ground cover severly disturbed by logging and road construction. This is the area from which most of the potential sediment would originate.

Table 159 - Projected Cumulative Timber Harvest Activity, Forest Land, Subregion 3 1/

	Unit	1980	2000	2020
Timber Harvest Area	Acres	234,000	542,000	850,000
Road Construction	Miles	1,400	3,300	5,100
Ground Disturbance 2/	Acres	49,000	114,000	179,000

1/ Based on the 1965 level of timber requirements.
2/ Includes both harvest area requiring protection and road mileage, converted to acres, requiring cut and fill treatment.



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

POTENTIAL EROSION HAZARD
FOREST LAND
YAKIMA, SUBREGION 3

1968

FIGURE 21

USDA-SCS-PORTLAND, OREG. 1969

With 850,000 acres coming under harvest by 2020, improved protection measures are necessary on both public and private forest lands. Cooperative programs and technical assistance should also be expanded to include more of the small private holdings.

Watershed Rehabilitation

Future demands for the subregion's water yields, particularly for irrigation, will require sustained and improved water quality through reduced sediment concentrations.

Watershed rehabilitation work is still required on much of the forest land in the "medium" sediment yield category (table 147). This is the critical area needing additional rehabilitation work; the reestablishment of trees and grass and the restoration of eroding stream channels.

Water Yield Improvement

Presently, over 90 percent of the subregion's runoff originates on the forest areas. Water yields can be improved by snowpack management and changes in the tree canopy, where the snowpack is concentrated and snowmelt and evaporation retarded. The water retention capacity has been determined for the forest soils of the subregion. It is mapped on figure 22 and summarized on table 160. The 860,000 acres in the "medium" class, having a storage potential of 1.2 million acre-feet, offer the best opportunity to apply these practices.

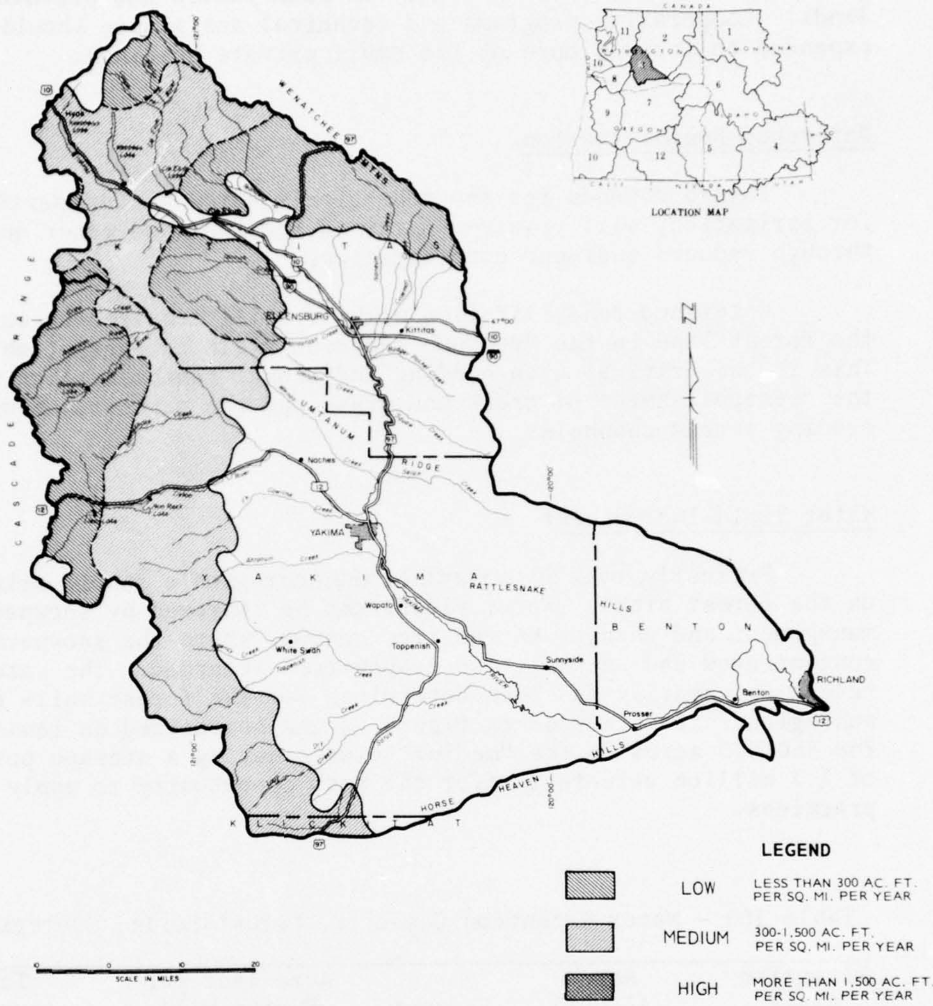
Table 160 - Water Retention Capacity, Forest Soils, Subregion 3

Retention Class	Acres (1,000)	Percent	Acre-feet per Square Mile	Total Acre-feet
Low	648.9	43	Less than 300	304,000
Medium	860.0	57	300 - 1,500	1,200,000
High	--	--	More than 1,500	--
Total	1,508.9	100		1,504,000

Source: Soil Survey Data and Interpretations, Forest Service, Region 6.

Rangeland

Previous watershed measures have been effective in improving certain range areas, but others still have serious problems requiring attention. Water is being wasted, grazing resources are not well



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

WATER RETENTION CAPACITY
FOREST LAND

YAKIMA, SUBREGION 3

1968

USDA-SCS-PORTLAND, OREG. 1969

FIGURE 22

utilized, fish and game production is below its potential, and recreation use is minor. There is an increasing awareness on the part of most managers and users that the potential for development of range resources is far greater than present use and conditions indicate. Future use of range resources will be more intensive and this will require additional watershed protection.

Projected Use of Range Resources

Rangeland now provides forage that produces an estimated 4.2 percent of the total beef and sheep production of this subregion. In 1964, beef and veal production amounted to 84.9 million pounds. This is expected to increase to 263.4 million pounds or 210 percent by 2020. Sheep and lamb production of 5.4 million pounds in 1964 is expected to increase to 8.0 million pounds by 2020.(3) To meet part of the increase in livestock production demands, less costly range forage production must be increased to the extent commensurate with proper land management and resource utilization. The total range area of 1.5 million acres is expected to decrease to 1.4 million acres by 2020, a decline of about 107,000 acres or 7 percent.

Watershed Needs

An estimated 165,000 acres of rangeland received land treatment for erosion and sedimentation control by 1966 with accompanying flood control and drainage benefits. This included most cover improvement and soil stabilization measures shown on table 152. Where multiple practices were involved, overlapping acreage was deleted. An additional 219,000 acres will require treatment by 1980 including road stabilization work, 456,000 acres by 2000, and 678,000 acres by 2020. A number of small water control structures are also needed to assure adequate erosion and sediment control.

Protection and management practices have been applied on some 1.2 million acres of rangeland by 1966, including reduction or adjustment of livestock grazing use to the grazing capacity of the range, and special fire control practices where required. Other management practices for improved livestock distribution and control include development of livestock and game water facilities and construction of livestock control fences. These protection and management practices should be extended to an additional 75,000 acres by 1980, 145,000 acres by 2000, and 205,000 acres by 2020.

An estimated 60 miles of streams and waterways in rangeland areas have been improved through 1965 by stream clearance, channel improvement, or efforts to improve water quality. A greater

mileage, given in the "Present Status" section for pollution abatement efforts, included considerable areas of recurrent practices. An additional 120 miles need attention by 1980, 240 miles by 2000, and 360 miles by 2020.

Little more than 1 mile of bank stabilization work has been accomplished in rangeland areas. This includes the stream and bank stabilization acreages reported in the "Present Status" section with conversion to miles on the basis of 10 acres per mile. Future needs include an additional 8 miles of bank stabilization along streams or reservoirs by 1980, 58 miles by 2000, and 98 miles by 2020.

About 22 miles of dikes have been constructed to help provide flood control and prevent damage from sediment and debris. An additional 16 miles of dikes will be needed by 1980, 19 miles by 2000, and 22 miles by 2020.

Other Land

Other land requirements are expected to increase about 52,000 acres by 2020. The projected 95 percent rise in population (216,100 people) will require 21,000 acres more land for urban, industrial, roads, and other miscellaneous uses.

Water needs for municipal, industrial, nonfarm irrigation, and rural domestic uses will increase in relation to population growth and expansion of urban and suburban areas. More efficient water management practices, required in the irrigation of lands in these areas and along roadsides, are expected to increase from 15,000 acres to 20,000 acres by 2020. Improvement is required for increased storage and supply facilities, to assure adequate water quality and quantity.

Facilities to handle sanitary disposal of wastes will also parallel population growth with more lands needed for soil filter fields and sanitary land fill for sewage and garbage disposal. Urban expansion construction will increase erosion, sedimentation, and flood hazards caused by removal of natural cover and by increased runoff. Flood prevention is required to protect the 13,600 acres now subject to frequent flooding and to assure improvement in these conditions as natural cover is disturbed over an expanded area.

All other land areas will need land treatment measures for drainage, flood protection, and erosion control to prevent water pollution, soil loss, and drainage from debris and sediment. More study is required of lands in the other land category to properly identify and present future needs.

MEANS TO SATISFY NEEDS

A combination of improved management practices, land treatment measures, and water control structures will be necessary to satisfy future watershed needs. Many of these requirements will be in upper watershed areas to protect or improve downstream watershed conditions.

Frequently, the most effective means to satisfy watershed requirements is by cooperative efforts of the landowners. Of the 30 watersheds in this subregion, 24 have been identified as having a complexity of problems which will require coordinated planning and development efforts. These are listed on table 161 by type of problem and by time period. Location of these areas is shown on figure 23.

Table 161 - Practices Required for Cooperative Conservation Development, Subregion 3

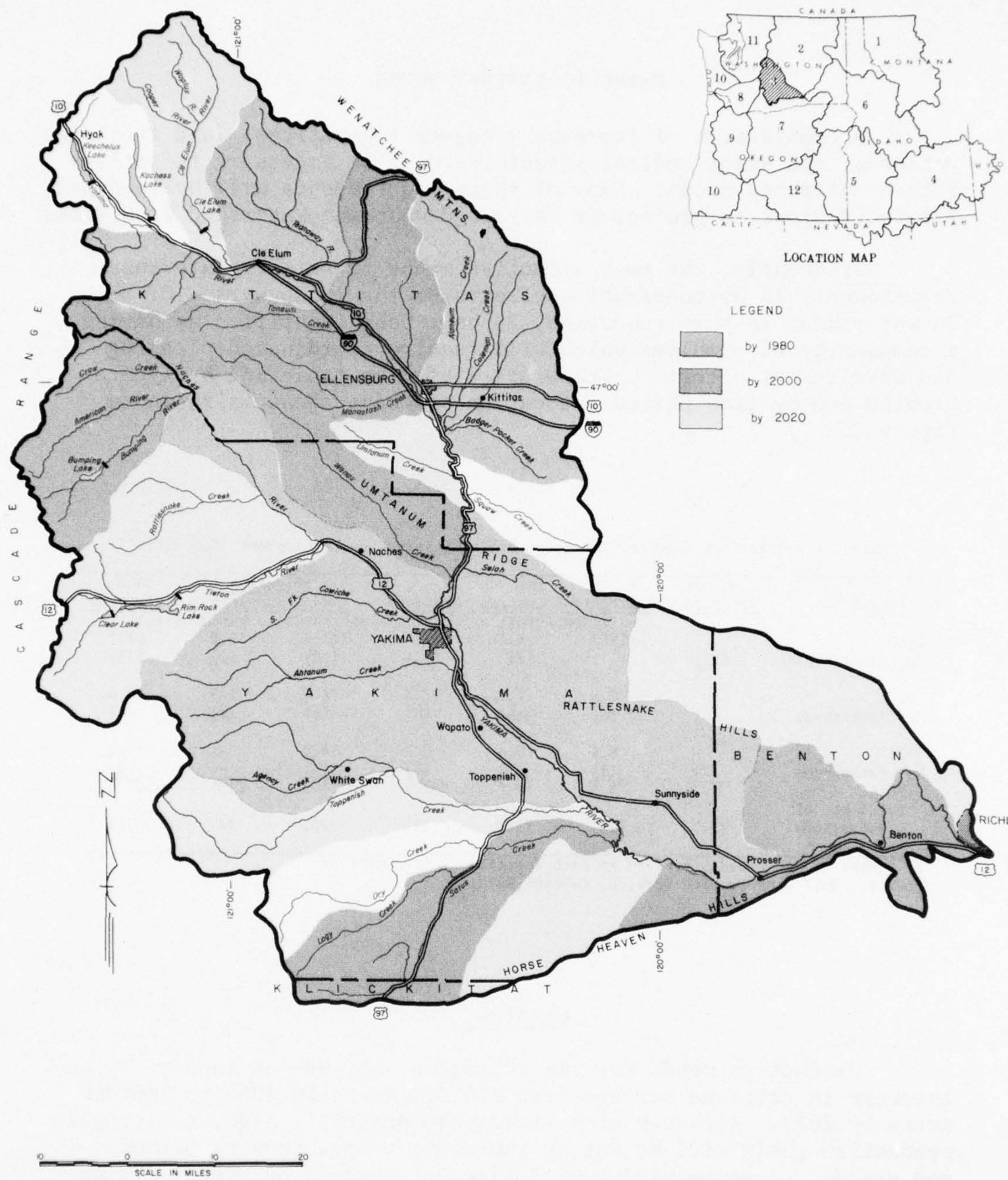
Target Date	No. of Watersheds	Flood Protection	Erosion Control	Drainage	Irrigation New	Irrigation Supplement	Land Treatment
		(1,000 acres, w/number of watersheds in parentheses)					
1980		59.7	8.3	31.7	142.0	16.0	99.7
No. Watersheds 1/	(11)	(11)	(11)	(11)	(10)	(2)	(11)
2000		7.5	2.2	7.3	78.6	5.5	17.0
No. Watersheds	(6)	(6)	(6)	(6)	(6)	(2)	(6)
2020		6.0	0.4	0.9	54.0	-	7.3
No. Watersheds	(7)	(1)	(1)	(2)	(4)	-	(2)
Total		73.2	10.9	39.9	274.6	21.5	124.0
Total No. of Watersheds	(24)	(18)	(18)	(19)	(20)	(4)	(19)

1/ Number of watersheds involved in each function by time periods.
Source: Soil Conservation Service, C-NPRBS Data.

Cropland

Production needs for the subregion will be met in part by an increase in cropland acreage from 686,000 acres in 1966 to 768,000 acres by 2020. Although crop yields are presently high, additional production goals will be met by improving crops, growing methods, and yields. Acreage yields will also be enhanced by proper irrigation, adequate drainage, and increased protection from flooding and erosion.

Additional cropland is available from land presently not cultivated but capable of more intensive use (table 162).



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

AREAS NEEDING COOPERATIVE WATERSHED DEVELOPMENT

YAKIMA, SUBREGION 3

1968

FIGURE 23

Table 162 - Land Areas Suitable for Crop Production, Subregion 3, 1966

Capability Class[1/]	Area	Percent
	(1,000 acres)	
I	51.8	5
II	255.3	24
III	330.6	31
IV	425.2	40
Total	1,062.9[2/]	100

1/ Defined in the Glossary.
2/ About 400,000 acres of Class VI semiarid land are also arable when irrigated.
Source: Appendix IV, Land and Mineral Resources.

Water Conservation

Irrigation is expected to increase from 490,000 acres in 1966 to 590,000 acres by 2020 in response to production needs. Most of this increase will be made available from additional storage, although there is potential for developing more ground water.

Management of irrigation water will improve from the present 5.0 acre-feet per acre to 4.5 acre-feet by 2020. This will be done by an increase in the use of sprinklers and reuse of irrigation water runoff. Sprinkler irrigation will be used to provide for efficient irrigation because it requires less labor than other surface irrigation methods. Projected practices for more efficient use of irrigation water are shown in table 163.

Table 163 - Cumulative Projected Practices for Irrigated Cropland, Subregion 3

Practice	Units	1966	1980	2000	2020
Water Control Facilities	No.	7,879	8,480	9,640	10,800
Irrigation Water Conveyance	Miles	5,936	6,300	7,200	8,000
Water Storage	No.	6	8	11	14
Irrigation Systems, Surface	No.	3,900	3,100	2,000	900
Irrigation Systems, Sprinkler	No.	1,800	4,000	5,500	7,000
Land Shaping	1,000 acs.	156	170	190	210
Irrigation Water Management	1,000 acs.	176	275	420	550

Source: Soil Conservation Service, C-NPRBS Data.

Only three of the water storage sites have been identified, having a total capacity of 5,800 acre-feet. Detailed study is

AD-A036 548 PACIFIC NORTHWEST RIVER BASINS COMMISSION VANCOUVER WASH F/G 8/6
COLUMBIA-NORTH PACIFIC REGION COMPREHENSIVE FRAMEWORK STUDY OF --ETC(U)
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needed to identify additional water storage sites for flood protection, irrigation, municipal and industrial supplies, recreation, and pollution reduction.

Drainage

Treatment of 128,000 acres of cropland having drainage problems by 2020 will require application of standard water control measures in progressive increments as shown on table 164. A higher degree of drainage will be installed on some of the better soils to grow a greater variety of crops.

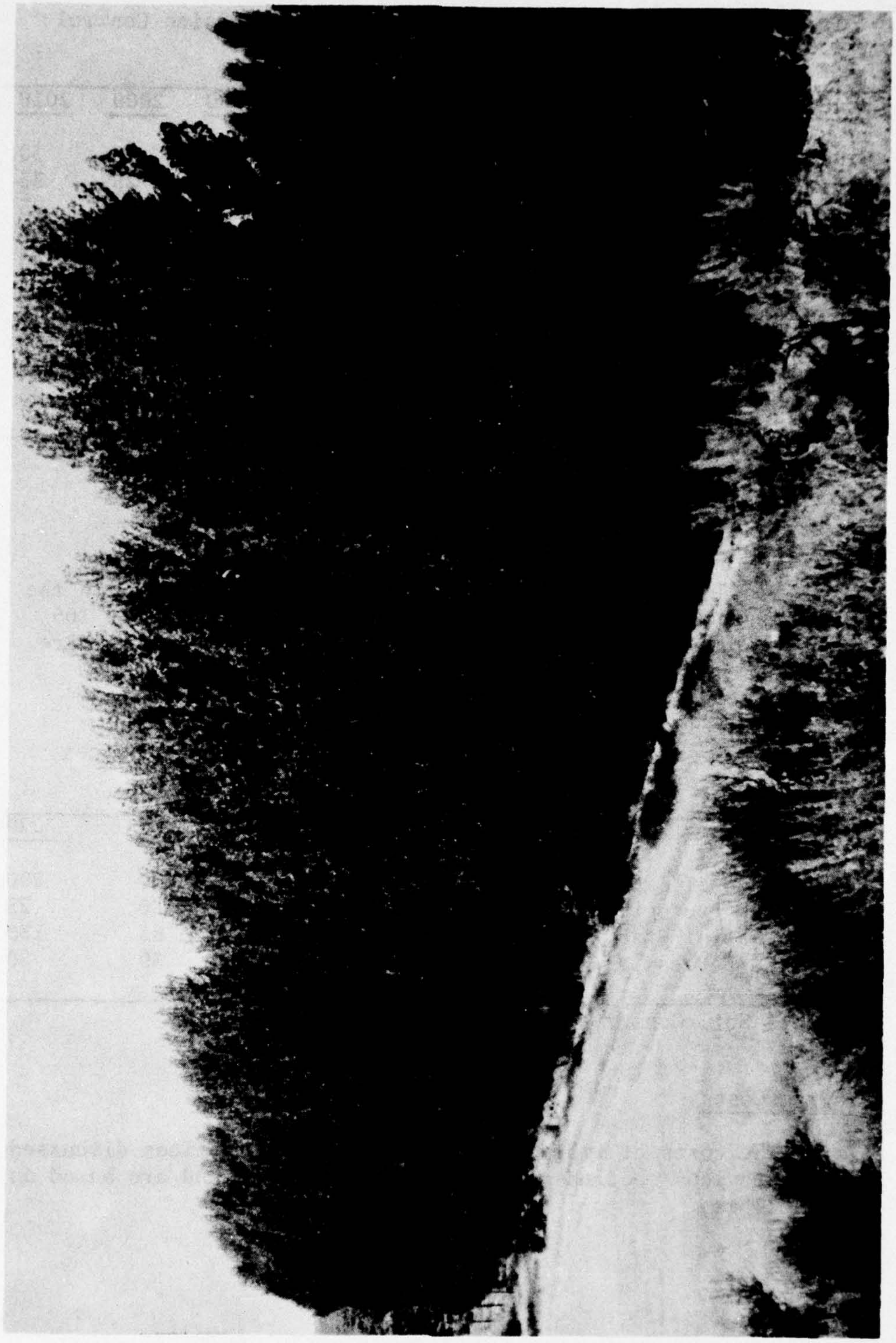
Table 164 - Cumulative Practices Required to Provide Needed Drainage, Subregion 3

Practice	Unit	1966	1980	2000	2020
Drainage Conduits and Ditches	Miles	1,690	1,810	2,060	2,310
Drainage Structures	No.	858	920	1,050	1,170

Source: Soil Conservation Service, C-NPRBS Data.

Erosion and Sedimentation

To control erosion on the 11,000 acres now presenting a problem, and to maintain adequate erosion control on all cropland by 2020, it will be necessary to increase and maintain protective measures as given in table 165. Anticipated protective measures in conjunction with different cropping patterns and more irrigation should eliminate erosion problems on all but 3,000 acres by 2020. These listed practices, when used along or in combinations or sequence, will respond to soil and water conservation needs.



One method of protecting cropland from erosion by wind is to provide a windbreak along the edge of the fields. (SCS W-3894-11)

Table 165 - Cumulative Practices to Satisfy Erosion Control Needs, Subregion 3

Practice	Unit	1966	1980	2000	2020
Grade Stab. Structures	No.	9	12	18	30
Diversions & Terraces	Miles	10	15	25	35
Ditch Bank Seeding	Miles	37	52	70	95
Field Windbreaks	Miles	17	43	70	80
Crop Residue Use	1000 Acs.	209	350	565	780
Stubble Mulch	1000 Acs.	83	100	125	150
Grassed Waterways	1000 Acs.	1	2	3	5
Stripcropping	1000 Acs.	3	7	14	20
Cons. Cropping System	1000 Acs.	250	420	660	900
Pasture & Hayland Planting	1000 Acs.	63	70	80	90

Source: Soil Conservation Service, C-NPRBS Data.

Flooding

Flood protection will be provided in conjunction with the development of water for irrigation and other uses. Table 166 shows the projected stream channel and diking measures that are considered necessary to reduce local flooding.

Table 166 - Cumulative Cropland Flood Prevention Practices, Subregion 3

Practice	Unit	1966	1980	2000	2020
Stream Channel Imp.	Miles	123	170	230	290
Streambank Protection	Miles	11	15	20	25
Stream Channel Stab.	Miles	21	50	95	139
Dikes and Levees	Miles	19	28	39	50

Source: Soil Conservation Service, C-NPRBS Data.

Program Costs

The costs of implementing conservation practices discussed in the previous sections are given in table 167, and are based on 1969 dollars.

Table 167 - Estimated Cost of Cropland Conservation Practices, Subregion 3

Item	Water Conservation	Drainage	Erosion Control	Flood Control	Total
			(1,000 dollars)		
1966-1980					
Private Funds	193,145	9,072	25,693	37,191	265,101
Public Funds	29,453	329	3,110	45,456	78,348
Technical 1/	11,029	1,410	2,592	7,438	22,469
Total	233,627	10,811	31,395	90,085	365,918
1981-2000					
Private Funds	327,590	15,018	50,058	54,780	447,446
Public Funds	44,290	545	5,406	66,974	117,215
Technical 1/	18,594	2,334	4,992	10,956	36,876
Total	390,474	17,897	60,456	132,710	601,537
2001-2020					
Private Funds	395,986	19,516	51,941	55,228	522,671
Public Funds	47,154	708	6,289	67,501	121,652
Technical 1/	22,157	3,050	5,240	11,046	41,493
Total	465,297	23,274	63,470	133,775	685,816

1/ Includes public and private costs.
Source: Soil Conservation Service, C-NPRBS Data.

Forest Land

Increasing demands for lumber and plywood will add to the pressures on the forest resources on the subregion. These demands can be met without damage to the watersheds, but only by accelerating levels of watershed protection, increasing the rate of rehabilitation of presently eroding areas, and improving streamflows through intensified management. These practices must be incorporated in the development for the subregion, whether projects, programs, or preservation is the ultimate plan.

Watershed Protection

It is expected that these demands will cause increased logging and road construction activity on the subregion's forest lands. This will be accompanied by higher standards of watershed protection. A level equivalent to that presently on the public lands will be necessary on the private areas by the year 2020, especially on lands with a high sediment yield potential. Table 168 outlines the anticipated total cost of such practices, accumulated through the year 2020. These costs are based on the

Table 168 - Projected Costs for Watershed Protection Practices, Forest Land, Subregion 3

Practices	Unit	Total Units1/	Total Cost1/ ($1,000)
PUBLIC FOREST LAND			
Logging Disturbance Treatment	Ac.	74,000	1,480
Harvest Road Treatment2/	Mi.	2,900	725
Other Watershed Requirements3/	Ac.	1,111,000	26,395
Total Cost			28,600
PRIVATE FOREST LAND			
Logging Disturbance Treatment	Ac.	54,000	810
Harvest Road Treatment	Mi.	2,200	440
Other Watershed Requirements	Ac.	383,000	13,590
Total Cost			14,840
TOTAL ALL LAND			
Logging Disturbance Treatment	Ac.	128,000	2,290
Harvest Road Treatment	Mi.	5,100	1,165
Other Watershed Requirements	Ac.	1,494,000	39,985
Total Cost			43,440

1/ Total for 55-year period 1965-2020. Costs in 1969 dollars.
2/ Includes road maintenance.
3/ Includes watershed surveys, plans, fire protection, timber cultural practices, and other indirectly related items.

assumption that: (1) On the public forest lands, controls through the timber sale and construction contracts are adequate when properly applied and (2) on the private forest lands, the minimum required by year 2020 will be about equal to current levels on the public lands.

At the rate shown on this table, recurrent watershed protection measures will cost about $520,000 annually on the public forest lands and should cost $270,000 annually on the private lands. Converting the annual costs to totals, this amounts to $43,440,000, representing the cost of maintaining the productive condition of the forest watersheds under the pressure of future projected demands.

Watershed Rehabilitation

Forest lands most in need of rehabilitation and, consequently, those that would benefit most in terms of sediment reduction, are the areas in the "medium" yield category as listed in table 147. These areas are now producing about 40 acre-feet, or 20 percent, of the total annual sediment from all forest lands in the subregion. The acreage presently requiring treatment and the amount that should be accomplished during time periods 1980, 2000, and 2020 are listed in table 169. The expected sediment reduction accomplished by these measures is listed in table 170.

Table 169 - Projected Watershed Rehabilitation Programs, Forest Land, Subregion 3

Program	Unit	1980 Amount	1980 Cost 1/ ($1,000)	2000 Amount	2000 Cost 1/ ($1,000)	2020 Amount	2020 Cost 1/ ($1,000)
FEDERAL LANDS							
Land Treatment	Ac.	5,100	1,951	7,050	2,731	7,050	2,731
Stream Rehabilitation	Mi.	91	1,416	120	1,886	120	1,886
Road Rehabilitation	Mi.	150	54	101	36	50	18
Total Cost			3,421		4,653		4,635
NONFEDERAL LANDS							
Land Treatment	Ac.	3,600	40	12,000	110	13,500	115
Stream Rehabilitation	Mi.	24	24	70	248	35	87
Road Rehabilitation	Mi.	80	2	154	4	105	3
Total Cost			66		362		205
TOTAL ALL LANDS							
Land Treatment	Ac.	8,700	1,991	19,050	2,841	20,550	2,846
Stream Rehabilitation	Mi.	115	1,440	190	2,134	155	1,973
Road Rehabilitation	Mi.	230	56	255	40	155	21
Total Cost			3,487		5,015		4,840

1/ In 1969 dollars.

The overall expected sediment reduction is 12 percent, or 23 acre-feet per year, primarily from watersheds in the poorest condition. In addition to the needs for sediment reduction on critically eroding forest lands, nonrecurrent work will also be required on both future extensive forest burns and lands directly related to planned water storage projects. Shoreline stabilization to reduce wave action erosion and stump and debris removal to improve recreation use, are examples of this. Some of this needed work is pictured on the following page. These problems will be treated as they occur. Thus, the 12 percent overall sediment

Removal of these stumps will provide additional boating water in this reservoir, as well as improvement of its esthetic value. (Forest Service)

Table 170 - Expected Annual Sediment Reduction
Forest Land Rehabilitation, Subregion 3

Present Yields	Acres (1,000)	Total Sed. Yield Ac-ft./Yr.	Acres Treated 2/	Sediment Reduction Ac-ft./Yr.
Very Low	420.4	13	--	--
Low	970.8	152	--	--
Medium	117.7	37	81,000	23.0
High	--	--	--	--
Very High	--	--	--	--
Total	1,508.9	202		23.0
			Total reduction, percent	12

1/ Data from table 147.
2/ Data from table 169. Miles treated converted to acres.

reduction is that amount possible, excluding new sources from major fire or other natural disaster.

Water Yield Improvement

The projected water yield improvement programs needed and the amount that should be accomplished during time periods 1980, 2000, and 2020 are listed in table 171. Timber harvest on the private forest lands is adjusted principally to meet silvicultural requirements. Therefore, neither water yield improvement practices nor benefits are estimated, although some benefit does occur.

Table 171 - Projected Water Yield Improvement Practices, Public Forest Land, Subregion 3

Program	Unit	1980 Amount	1980 Cost 1/ ($1,000)	2000 Amount	2000 Cost 1/ ($1,000)	2020 Amount	2020 Cost 1/ ($1,000)
Cover Manipulation 2/	Ac.	13,250	139	16,000	160	16,000	160
Snowpack Management	Mi.	200	10,000	310	15,500	360	18,000
Water Spreading 3/	Ac.	7,000	49	10,600	89	14,500	122
Total Cost			10,188		15,749		18,282

1/ In 1969 dollars.
2/ Includes type conversion and riparian vegetation management.
3/ Planned for altering timing of runoff or ground-water recharge, not for irrigation or other resource activity.

Total Program Costs

In summary, the total cost of the forest watershed protection and land treatment programs through the year 2020 are presented below:

	Costs ($1,000)
Watershed Protection	43,440
Watershed Rehabilitation	13,342
Water Yield Improvement	44,219
	101,001

Rangeland

Measures and Practices for Watershed Protection

Requirements for future rangeland watershed protection, rehabilitation, and improvement in Subregion 3 are listed on tables 172, 173, and 174. Most of these measures and practices which improve watershed conditions also have other purposes.

Table 172 - Required Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, 1966 to 1980, Subregion 3

Measures & Practices	Units	Land Ownership			Watershed Purposes 1/			
		Public 2/	Private	Total	(1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	29,600	16,200	45,800	-	x	x	x
Brush Control	Acres	177,100	97,400	274,500	-	x	x	-
Weed Control	Acres	26,000	14,300	40,300	-	x	-	-
Fertilizing	Acres	42,600	23,500	66,100	-	x	x	-
Contouring, Pitting, Furrowing	Acres	4,400	2,400	6,800	-	x	-	-
Deep Tillage	Acres	1,000	600	1,600	-	x	-	-
Stream & Bank Stabilization	Acres	50	30	80	-	-	x	-
Waterspreading	Acres	2,100	1,100	3,200	-	x	-	-
Irrigation	Acres	120	70	190	-	x	-	-
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	400	300	700	-	-	x	-
Reducing Excessive Grazing Use	Acres	18,400	10,100	28,500	-	x	x	-
Livestock & Game Water Facilities	Number	300	100	400	-	x	-	-
Special Fire Control	Acres	886,000	487,300	1,373,300	-	x	x	-
Road Stabilization								
New Roads	Miles	20	10	30	-	-	x	x
Stream Clearance	Miles	30	20	50	-	-	-	-
Pollution Abatement	Miles	500	200	700	-	-	x	-
Water Control Structures								
Ponds & Small Reservoirs	Number	200	100	300	-	x	x	-
	Acre Ft.	200	100	300	-	x	x	-
Detentions	Number	50	30	80	-	x	x	x
	Cu. Yds.	51,000	28,000	79,000	-	x	x	x
Check Dams (Gully Plugs)	Number	1,800	1,000	2,800	-	-	x	x
	Cu. Yds.	19,600	10,800	30,400	-	-	x	x
Dikes	Lin. Ft.	53,000	29,200	82,200	-	-	x	x
Diversions	Number	70	40	110	-	x	x	x
	Cu. Yds.	31,000	17,100	48,100	-	x	x	x

1/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control, Col. 4-Flood & Debris Control.
2/ Includes Federal, State, County, and Municipal Ownership.
Source: Data collected from land management agencies specifically for the C-NP Study.

Table 173 - Required Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, 1981 to 2000, Subregion 3

Measures & Practices	Units	Land Ownership			Watershed Purposes 1/			
		Public 2/	Private	Total	(1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	27,500	15,200	42,700	-	x	x	x
Brush Control	Acres	173,200	95,300	268,500	-	x	x	-
Weed Control	Acres	26,700	14,700	41,400	-	x	-	-
Fertilizing	Acres	14,700	8,100	22,800	-	x	x	-
Contouring, Pitting, Furrowing	Acres	16,700	9,200	25,900	-	x	-	-
Deep Tillage	Acres	18,400	10,100	28,500	-	x	-	-
Stream & Bank Stabilization	Acres	300	200	500	-	-	x	-
Waterspreading	Acres	24,500	13,400	37,900	-	x	-	
Irrigation	Acres	400	200	600	-	x	-	-
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	300	200	500	-	-	x	-
Livestock & Game Water Facilities	Number	130	70	200	-	-	x	x
Special Fire Control	Acres	886,600	487,600	1,374,200	-	x	x	-
Road Stabilization								
Existing Roads	Miles	170	100	270	-	-	x	x
New Roads	Miles	70	40	110	-	-	x	x
Abandoned Roads	Miles	70	40	110	-	-	x	-
Stream Clearance	Miles	30	20	50	-	-	x	-
Pollution Abatement	Miles	500	200	700	-	-	x	x
Water Control Structures								
Ponds & Small Reservoirs	Number	200	100	300	-	x	x	x
	Acre Ft.	200	100	300	-	x	x	x
Detentions	Number	4	2	6	-	x	x	x
	Cu. Yds.	600	300	900	-	x	x	x
Check Dams (Gully Plugs)	Number	900	500	1,400	-	x	x	x
	Cu. Yds.	12,300	6,700	19,000	-	x	x	x
Dikes	Lin. Ft.	11,200	6,200	17,400	x	x	x	x
Diversions	Number	80	40	120	-	x	x	x
	Cu. Yds.	30,700	16,900	47,600	-	x	x	x

1/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4-Flood & Debris Control.
2/ Includes Federal, State, County, and Municipal Ownership.
Source: Data collected from land management agencies specifically for the C-NP Study.

Table 174 - Required Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, 2001 to 2020, Subregion 3

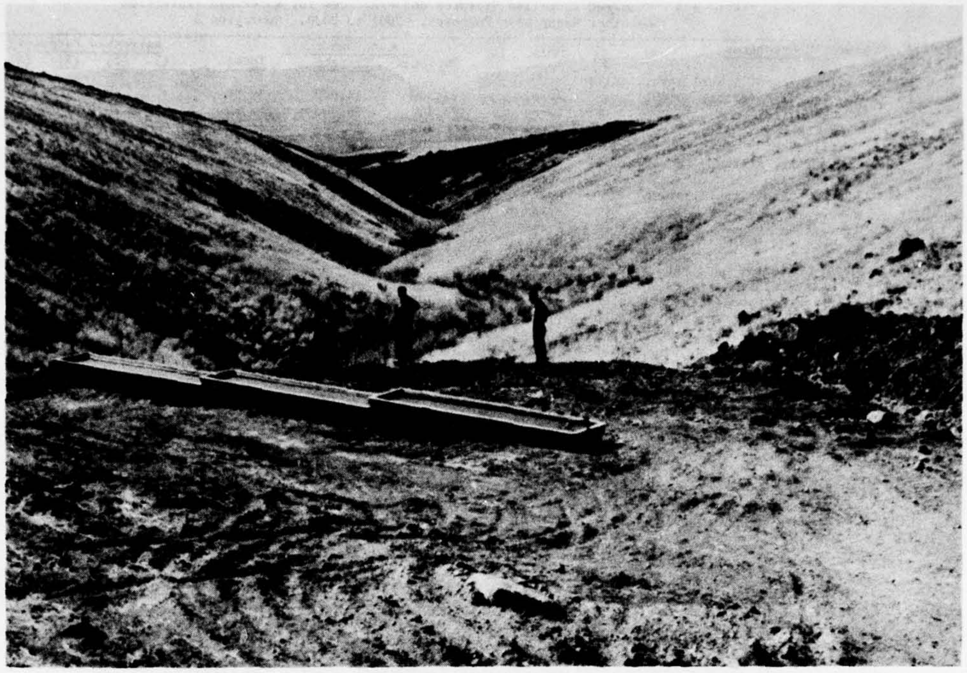
Measures & Practices	Units	Land Ownership			Watershed Purposes 1/			
		Public 2/	Private	Total	(1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	25,500	14,000	39,500	-	x	x	x
Brush Control	Acres	173,400	95,400	268,800	-	x	x	-
Weed Control	Acres	26,900	14,800	41,700	-	x	-	-
Fertilizing	Acres	13,900	7,600	21,500	-	x	x	-
Contouring, Pitting, Furrowing	Acres	16,900	9,300	26,200	-	x	-	-
Deep Tillage	Acres	18,400	10,100	28,500	-	x	-	-
Stream & Bank Stabilization	Acres	300	100	400	-	-	x	-
Waterspreading	Acres	8,100	4,500	12,600	-	x	-	-
Irrigation	Acres	400	200	600	-	x	-	-
Watershed Oriented Land Mgt. Practices								
Livestock Control Fences	Miles	200	100	300	-	-	x	-
Livestock & Game Water Facilities	Number	100	100	200	-	-	x	x
Special Fire Control	Acres	886,600	487,600	1,374,200	-	x	x	-
Road Stabilization								
Existing Roads	Miles	300	100	400	-	-	x	x
New Roads	Miles	100	55	155	-	-	x	x
Abandoned Roads	Miles	20	10	30	-	-	x	-
Stream Clearance	Miles	30	20	50	-	-	x	-
Pollution Abatement	Miles	500	200	700	-	-	x	x
Water Control Structures								
Ponds & Small Reservoirs	Number	65	35	100	-	x	x	x
	Acre Ft.	70	30	100	-	x	x	x
Detentions	Number	4	2	6	-	x	x	x
	Cu. Yds.	600	300	900	-	x	x	x
Check Dams (Gully Plugs)	Number	600	400	1,000	-	x	x	x
	Cu. Yds.	10,200	5,600	15,800	-	x	x	x
Dikes	Lin. Ft.	10,200	5,600	15,800	x	x	x	x
Diversions	Number	45	25	70	-	-	x	-
	Cu. Yds.	25,500	14,100	39,600	-	-	x	-

1/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4-Flood & Debris Control.
2/ Includes Federal, State, County, and Municipal Ownership.
Source: Data collected from land management agencies specifically for the C-NP Study.

Cover improvement and soil stabilization practices will be required on a total 1.4 million acres of rangeland between 1966 and 2020. Many of these will be recurrent efforts, and a combination of practices will be applied on some of the same areas. About 128,000 acres will need revegetation and brush should be controlled on some 812,000 acres (includes recurrent control on 518,000 acres). About 35 percent of these practices will be for improved watershed conditions, and 65 percent will be for forage production. An estimated 98 miles of bank stabilization should be accomplished along streams and reservoirs by revegetation and structural measures.

Various grazing management systems must be adopted to increase range grazing capacity while at the same time providing adequate cover improvement and soil stabilization for watershed protection. These efforts should be accompanied by construction of about 1,500 miles of livestock fencing and development of 800 livestock and game water facilities. On most rangeland areas, special fire prevention efforts are needed to permit early detection and suppression action while fires are still small.

About 670 miles of existing roads, 300 miles of new roads and 140 miles of abandoned roads, will require soil stabilization practices to prevent erosion and excessive runoff. Stream



Additional water facilities should be developed for improved livestock distribution and increased utilization of range resources, such as this spring development in Rattlesnake Canyon, near Yakima. (SCS W-1901-7)

clearance is needed along some 150 miles of waterways and pollution abatement treatment will be needed along approximately 700 miles of stream (most of this represents a recurring effort along streams currently receiving attention).

Erosion and Sediment Yield Improvement

The highest sediment yield areas in this subregion are in the "Low" and "Medium" categories (table 151), producing between .15 and .35 acre-feet of sediment per square mile each year. Some small, critically eroded areas are also located within the generalized "Very Low" category. Erosion and water quality control measures will be concentrated on the higher sediment yield areas. Adjustment of grazing use on some areas and improved vegetative cover along with an anticipated 7 percent decrease in range acreage, should result in a 13 percent reduction in annual sediment yield from 157 acre-feet in 1966 to 136 acre-feet by 2020 (table 175).

Table 175 - Annual Sediment Yield Projections from Rangeland, Subregion 3

Sediment Yield Categories 1/	1966	1980	2000	2020
		Rangeland Acreage (1,000 acres)		
Very Low	1,481.0	1,441.7	1,431.0	1,410.1
Low	34.6	30.0	23.9	17.9
Medium	19.2	14.3	7.1	-
High	-	-	-	-
Very High	-	-	-	-
Total	1,534.8	1,486.0	1,462.0	1,428.0
Percent Change from 1966	.0	-3.2	-4.7	-7.0
		Annual Sediment Yield (acre-feet)		
Very Low	139	135	134	132
Low	8	7	6	4
Medium	10	8	4	-
High	-	-	-	-
Very High	-	-	-	-
Total	157	150	144	136
Percent Change from 1966	.0	-4	-8	-13

1/ Very Low through Very High categories represent generalized range areas on which annual sediment yield per square mile averages .06, .15, .35, 1.00, and 2.75 acre-feet, respectively.

Improved Range Condition and Capacity

Estimated future range improvement is shown on table 176. In 1966 only 25 percent of the rangeland was in good condition. With scheduled improvements, good condition range will be increased to 63 percent by 2020, or from 384,000 acres to 899,000 acres. Poor condition range, accounting for 41 percent of the total acreage in 1966, will be reduced to 14 percent by 2020, decreasing from 637,000 acres to 207,000 acres. Despite a decrease of 107,000 acres of rangeland, the 1966 grazing capacity of 192,000 AUMs is expected to increase to 278,000 AUMs in 2020, an increase of 45 percent. Even with this improvement, range forage production will meet only about 2 percent of the anticipated demand for livestock production in Subregion 3 by 2020, compared to 4.2 percent in 1966.

Table 176 - Estimated Potential Rangeland Improvement, Subregion 3

Range Type and Comdition	1966		1980		2000		2020	
	Acres (1,000)	AUMs (1,000)	Acres (1,000)	AUMs (1,000)	Acres (1,000)	AUMs (1,000)	Acres (1,000)	AUMs (1,000)
Grassland								
Good	151.4	43.3	197.1	56.3	262.1	74.9	357.0	102.0
Fair	260.9	32.6	231.0	28.9	206.7	25.9	161.6	20.2
Poor	299.3	19.9	241.7	16.1	177.4	11.8	100.1	6.7
Seeded Range	55.8	18.6	92.3	30.8	116.4	38.8	138.7	46.2
Total	767.4	114.4	762.1	132.1	762.6	151.4	757.4	175.1
Sagebrush								
Good	163.3	32.6	203.5	40.7	304.4	60.9	378.6	75.7
Fair	234.4	21.3	211.8	19.2	166.5	15.1	140.8	12.8
Poor	312.5	17.0	253.2	13.8	174.0	9.5	98.0	5.3
Total	710.2	70.9	668.5	73.7	644.9	85.5	617.4	93.8
Other Brush								
Good	13.2	3.3	15.5	3.9	19.7	4.9	24.3	6.1
Fair	18.9	2.1	18.0	2.0	20.8	2.3	20.0	2.2
Poor	25.1	1.1	21.9	.9	14.0	.6	8.9	.4
Total	57.2	6.5	55.4	6.8	54.5	7.8	53.2	8.7
Total								
Good 1/	383.7	97.8	508.4	131.7	702.6	179.5	898.6	230.0
Fair	514.2	56.0	460.8	50.1	394.0	43.3	322.4	35.2
Poor	636.9	38.0	516.8	30.8	365.4	21.9	207.0	12.4
Grand Total	1,534.8	191.8	1,486.0	212.6	1,462.0	244.7	1,428.0	277.6

1/ Includes seeded range.
Source: Table 150 "Present Status" rangeland narrative. Future estimates for this study are based on representative on-site surveys for production guides with consideration to the capability of the range for improvement with proper management and utilization.

Estimated Program Investment Costs

Investment cost estimates (based on 1969 dollars) are shown in table 177 for all future measures and practices shown on tables 172, 173, and 174. Cover improvement and soil stabilization programs will require $3.2 million between 1966 and 2020, 44 percent of the total watershed program costs of $7.4 million. Watershed oriented land management costs require $3.5 million or 46 percent of total program costs, and water control structures require $734,000 or 10 percent of total costs.

Based on the present ratio of rangeland ownership, an estimated $4.8 million (65 percent of total requirements) will be directed to publicly owned rangeland. The private range will need $2.6 million or 35 percent of the total.

Table 177 - Estimated Cost of Required Measures and Practices for Watershed Protection and Rehabilitation of Rangeland by Major Types of Watershed Programs, Subregion 3 1/

Major Types of Watershed Programs	1966 to 1980 ($1000)	1980 to 2000 ($1000)	2000 to 2020 ($1000)	Total ($1000)
Public Land				
Cover Improvement and Soil Stabilization	452.0	859.4	790.6	2,102.0
Watershed Oriented Land Management Practices	701.1	762.7	793.5	2,257.3
Water Control Structures	178.2	213.3	88.5	480.0
Total	1,331.3	1,835.4	1,672.6	4,839.3
Private Land				
Cover Improvement and Soil Stabilization	250.4	493.0	392.8	1,136.2
Watershed Oriented Land Management Practices	374.5	413.3	411.2	1,199.0
Water Control Structures	94.9	110.7	48.0	253.6
Total	719.8	1,017.0	852.0	2,588.8
Total				
Cover Improvement and Soil Stabilization	702.4	1,352.4	1,183.4	3,238.2
Watershed Oriented Land Management Practices	1,075.6	1,176.0	1,204.7	3,456.3
Water Control Structures	273.1	324.0	136.5	733.6
Total	2,051.1	2,852.4	2,524.6	7,428.1

1/ Based on measures and practices shown on Tables 172, 173, and 174 with constant 1969 dollars.

Other Land

Joint coordinated planning must be accomplished by all levels of Government and private interests to meet watershed needs in a period of expanding development. Planning should provide for flood protection, drainage, water needs, recreation, fish and wildlife, and esthetic values. Urban needs must be closely coordinated with adjacent development of agricultural and rural areas.

In addition to the 18 watersheds with present water supply problems for municipal, industrial, and rural-domestic uses, problem areas will be increased by more population and associated land and water needs. More intensive study is required to determine the full extent of the problems and feasible solutions for adequate sewage treatment, pollution abatement, and sources of water.

Channel work, flood-water retention structures, or a combination of the two, will be required to reduce flood damage on the 13,600 acres now subject to frequent flooding, along with flood plain zoning to prevent this problem from growing.

Damages caused by flooding of urban properties along small tributaries result in phenomenal monetary losses. (SCS W-3285-6)

Intensive soil surveys and interpretations are needed in areas of future urban expansion to assist in planning. Soil interpretations should include considerations of drainage and flooding and sliding, as well as suitability for construction of foundations and drainfields. Results of these surveys should be reflected in urban and suburban zoning ordinances.

Erosion and sediment from adjacent lands and construction sites create continuing and increasing problems in urban and industrial areas. Measures to control these problems include land treatment on adjacent lands, more adequate floodways, debris basins, and strict construction controls to reduce damages.

In parts of the subregion, damage is caused by blowing sand and creation of dunes. An estimated 5,500 acres of dune stabilization work should be accomplished between 1966 and 2020. This includes planting or seeding of some areas and other measures to reestablish vegetative cover and to prevent expansion of sand areas.

Most measures and practices required to satisfy needs for other land have been included and costed in other sections of this appendix and in Appendices VII, Flood Control; IX, Irrigation; XI, Municipal and Industrial Water Supply; and XII, Water Quality and Pollution Control.

SUBREGION 4
UPPER SNAKE

PRESENT STATUS

Subregion 4 includes all the Snake River Drainage above King Hill. The total area is 22.9 million acres (13 percent of the region) including a land area of 22.7 million acres and 266,700 acres of large water bodies. Over 72 percent of this area is in public ownership, and the balance is private. The largest public ownership is Federal, nearly 60 percent in national forests and Bureau of Land Management grazing areas. Generalized cover and land use for the subregion is shown on figure 25 and table 178.

Average annual precipitation varies from less than 8 inches in the more arid areas of Idaho to more than 40 inches in the mountains of western Wyoming. Precipitation during the growing season is inadequate for dryland crop production in most of the subregion. The frost-free period varies greatly with elevation and other conditions, and ranges from 120 to 150 days along the Snake River near Rupert to about 110 days at Idaho Falls.

Total runoff for the subregion is 6.2 million acre-feet annually. These yields vary considerably but about half originate on forested areas (figure 25).

Highest sediment yields are from the rangeland areas, accounting for over 60 percent of the total. Another source is the cropland area in the Upper Snake River Plain (figure 26 and table 178).

Table 178 - Generalized Sediment Yield by Cover and Land Use, Subregion 4

Cover and Land Use	Acres (1,000)	Percent	Sediment Yield Ac.Ft./Year	Percent
Cropland	3,781.3	16	875	28
Forest Land	4,296.9	19	262	8
Rangeland	13,555.8	60	1,917	62
Other Land	1,047.8	5	49	2
Total	22,681.8	100	3,103	100

Source: Derived from figures 25 and 26, Appendix IV.

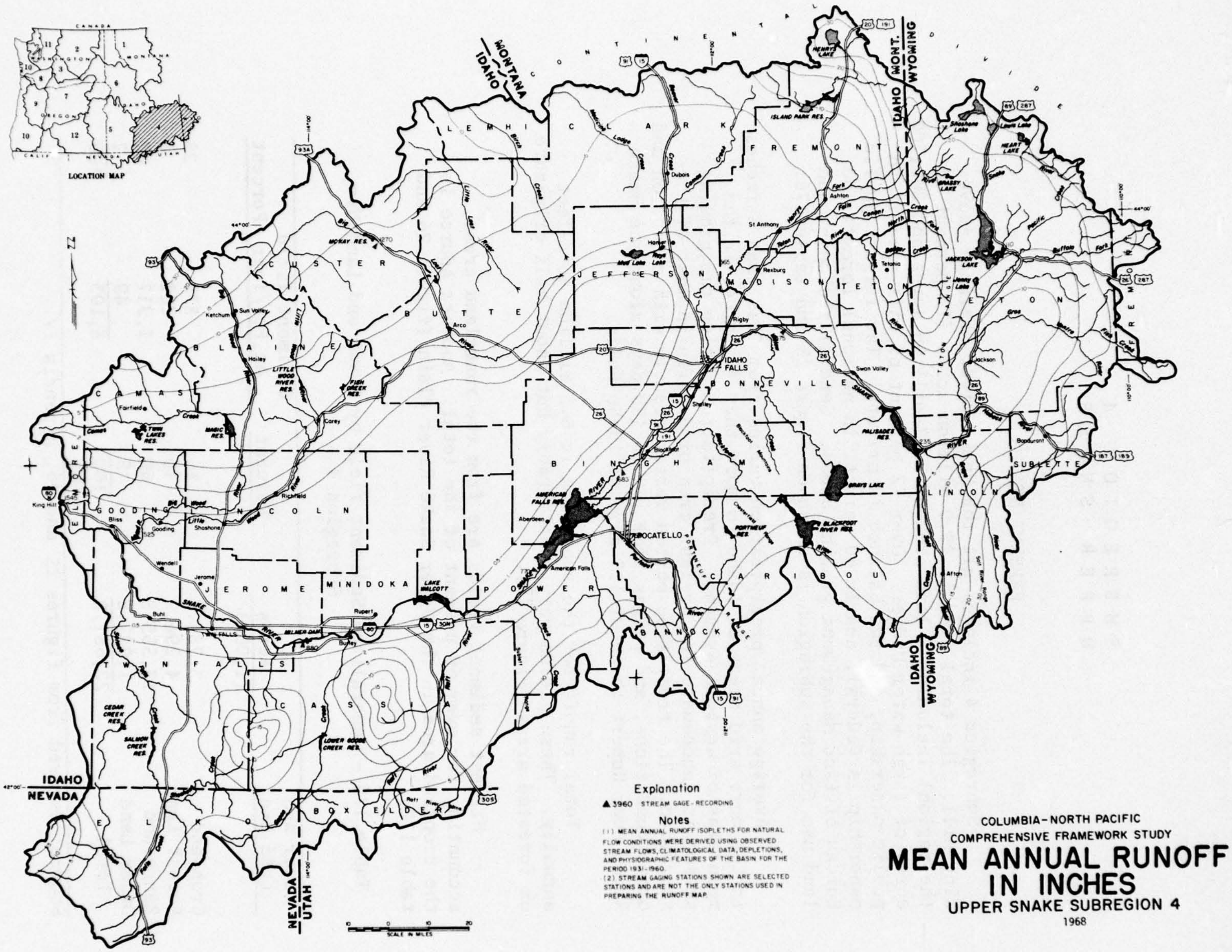
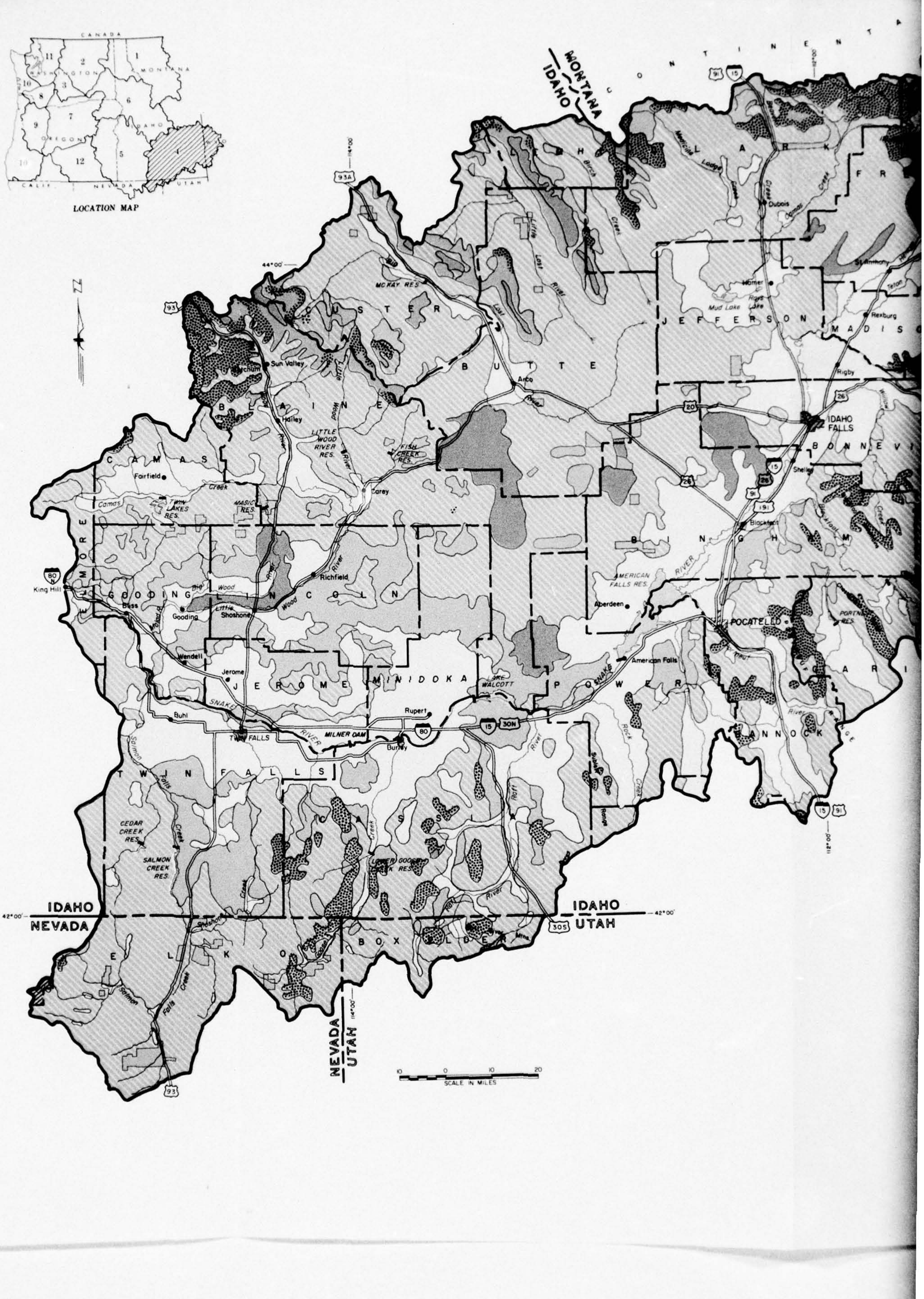

COLUMBIA - NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY
MEAN ANNUAL RUNOFF
IN INCHES
UPPER SNAKE SUBREGION 4
1968
Explanation
▲3960 STREAM GAGE - RECORDING
Notes
(1) MEAN ANNUAL RUNOFF ISOPLETHS FOR NATURAL FLOW CONDITIONS WERE DERIVED USING OBSERVED STREAM FLOWS, CLIMATOLOGICAL DATA, DEPLETIONS, AND PHYSIOGRAPHIC FEATURES OF THE BASIN FOR THE PERIOD 1931-1960
(2) STREAM GAGING STATIONS SHOWN ARE SELECTED STATIONS AND ARE NOT THE ONLY STATIONS USED IN PREPARING THE RUNOFF MAP.
LOCATION MAP
SCALE IN MILES
CONTINENTAL DIVIDE
MONTANA
IDAHO
IDAHO
WYOMING
IDAHO
NEVADA
NEVADA
UTAH
LEMHI
CLARK
FREMONT
CUSTER
BUTTE
JEFFERSON
MADISON
TETON
BLAINE
CAMAS
BONNEVILLE
BINGHAM
GOODING
LINCOLN
JEROME
MINIDOKA
POWER
CARIBOU
BANNOCK
TWIN FALLS
CASSIA
ELKO
BOX ELDER
SUBLETTE
IDAHO FALLS
POCATELLO
AMERICAN FALLS RES.
PALISADES RES.
JACKSON LAKE
ISLAND PARK RES.
LAKE WALCOTT
GRAYS LAKE
BLACKFOOT RIVER RES.
SNAKE RIVER

FIGURE 24



LOCATION MAP
CANADA
WASHINGTON
MONTANA
OREGON
IDAHO
NEVADA
UTAH
CALIF.
MONTANA
IDAHO
CONTINENTAL
CUSTER
BUTTE
BLAINE
CAMAS
GOODING
LINCOLN
JEROME
MINIDOKA
POWER
BINGHAM
JEFFERSON
BONNEVILLE
MADISON
CLARK
CARIBOU
BANNOCK
TWIN FALLS
CASSIA
ELKO
BOX ELDER
ELMORE
MC KAY RES.
LITTLE WOOD RIVER RES.
FISH CREEK RES.
TWIN LAKES RES.
MAGIC RES.
AMERICAN FALLS RES.
LAKE WALCOTT
MILNER DAM
CEDAR CREEK RES.
SALMON CREEK RES.
(LOWER) GOOSE CREEK RES.
Sun Valley
Ketchum
Hailey
Fairfield
Carey
Richfield
Arco
Dubois
Hamer
Mud Lake
St. Anthony
Rexburg
Rigby
IDAHO FALLS
Shelley
Blackfoot
Aberdeen
POCATELLO
American Falls
King Hill
Bliss
Gooding
Shoshone
Wendell
Jerome
Buhl
TWIN FALLS
Rupert
Burley
SNAKE RIVER
IDAHO
NEVADA
IDAHO
UTAH
NEVADA
UTAH
42°00'
44°00'
114°00'
112°00'
SCALE IN MILES
10 0 10 20

2

LEGEND

CROPLAND

RANGELAND

Grass and Meadowland

Sage and Other Brushland

FOREST LAND

Commercial

Non-Commercial

Forest Range

Reserved from Timber Harvest

OTHER LAND

COLUMBIA–NORTH PACIFIC

COMPREHENSIVE FRAMEWORK STUDY

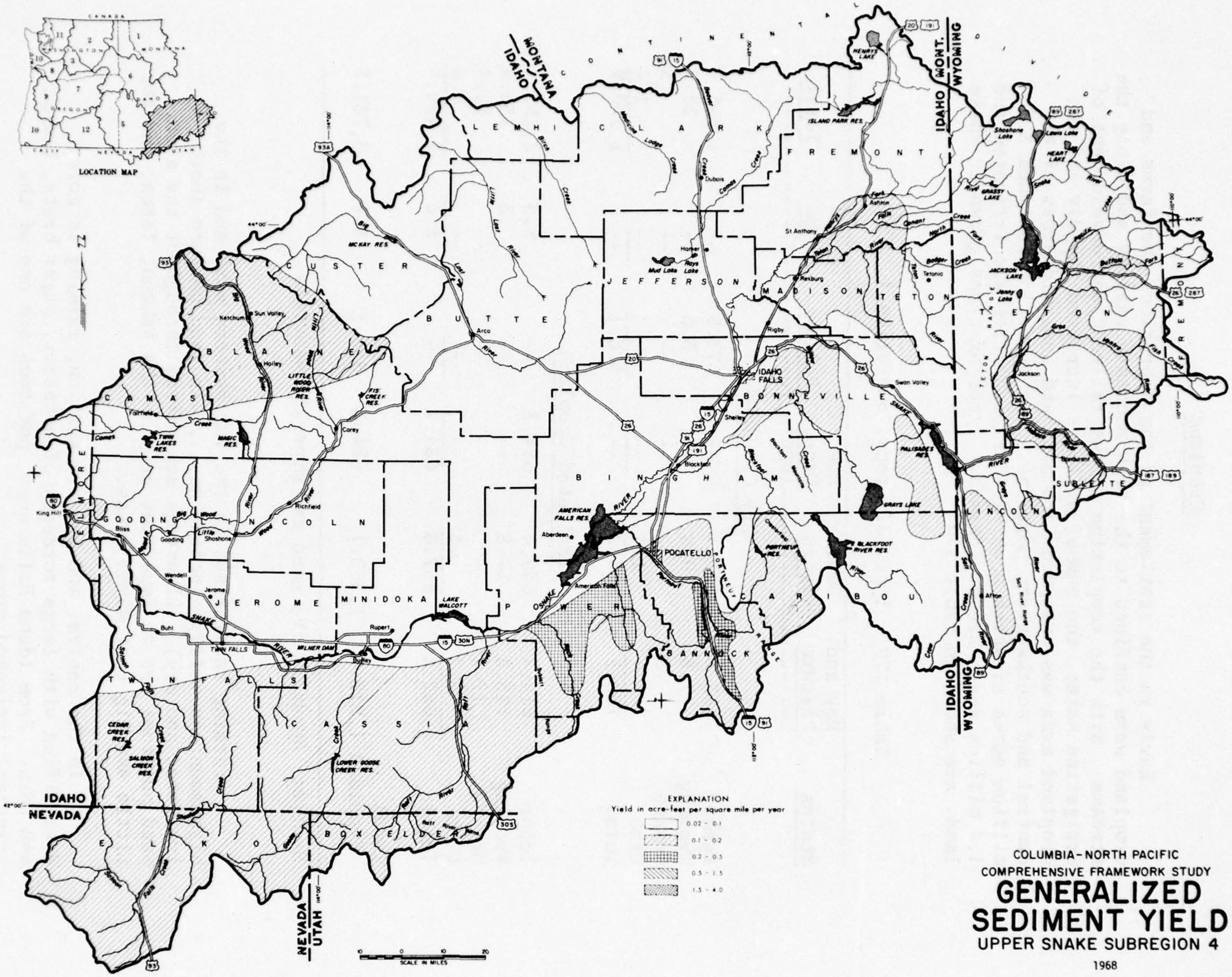
GENERALIZED COVER AND LAND USE

UPPER SNAKE, SUBREGION 4

1968

USDA-SCS-PORTLAND, OREG. 1970

FIGURE 25



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

GENERALIZED SEDIMENT YIELD

UPPER SNAKE SUBREGION 4

1968

FIGURE 26

Cropland

Early in the settlement of the subregion, the farms and cropland were confined to the high mountain valleys and along the streams. With the completion of the railroad and development of irrigation water, the number of farms increased rapidly and the cropland area was extended into arid and semiarid areas of the central and southwestern portions. The subregion includes 3.8 million acres of which about 2.4 million acres are irrigated and 1.4 million acres are dry-farmed. Types of crops grown on these lands are shown in table 179.

Table 179 - Types of Crops, Subregion 4, 1966

States	Hay and Pasture	Small Grain	Row Crops	Fallow	Field Crops	Total
	--------------------1000 acres-----------------------					
			Dry Cropland			
Idaho	152.2	622.1	--	572.5	--	1,346.8
Wyoming	7.8	10.8	--	3.6	--	22.2
Nevada	.5	--	--	--	--	.5
Utah	--	1.4	--	--	--	1.4
Total	160.5	634.3	--	576.1	--	1,370.9
			Irrigated Cropland			
Idaho	918.4	649.4	684.2	--	5.3	2,257.3
Wyoming	115.8	17.8	--	--	.3	133.9
Nevada	12.4	--	--	--	--	12.4
Utah	6.2	.6	--	--	--	6.8
Total	1,052.8	667.8	684.2	--	5.6	2,410.4
Total Cropland	1,213.3	1,302.1	684.2	576.1	5.6	3,781.3

Source: Appendix IV, Land and Mineral Resources

Farming enterprises in the far eastern part and in the high mountain valleys include hay, grain, and pasture (both irrigated and dry). Livestock are raised throughout the area. Seed potatoes are an important crop in the Ashton, Teton, and the Little and Big Lost River areas.

In the central and western portion, farming is more diversified with large acreages of potatoes, sugar beets, beans, and corn. From Idaho Falls west, potatoes are one of the principal irrigated crops.

Dryland wheat-fallow farming is scattered throughout the subregion. In the central and western areas it is grown primarily in the mountain valleys and on the upper slopes where rainfall is adequate. In the eastern portion where there is more precipitation, dryland wheat is one of the principal crops.

Water Conservation

All of the cropland is in an arid to semiarid climate, and water conservation is important to both irrigated and nonirrigated farming enterprises. Water conservation practices such as land leveling, installation of pipelines, lined ditches, and water control structures have improved the irrigation systems and brought about improved water management. Ponds and reservoirs are constructed to catch and store surface waste water. Pumps and pipelines are often installed to pump the waste water back on the land for reuse. Table 180 shows the present status of water conservation practices applied to the cropland in the subregion.

Table 180 - Water Conservation Practices Applied on Cropland, Subregion 4, 1966

Practice	Unit	Idaho	Wyoming	Utah	Nevada	Subregion
Water Control Facilities	No.	69,542	8,895	593	100	79,130
Irrigation Water Conveyance Facilities	Mi.	11,352	873	43	52	12,320
Water Storage Facilities	No.	1,437	24	23	26	1,510
Irrigation Systems, Surface & Subsurface	No.	1,723	36	1	20	1,780
Irrigation Systems, Sprinkler	No.	1,899	295	3	3	2,200
Irrigation Water Management	1,000 Ac.	824.0	15.5	.9	1.5	842.0
Land Shaping	1,000 Ac.	431.5	24.1	2.9	2.5	461.0

Source: Soil Conservation Service Data

Water conservation measures presently being used on nonirrigated land include: (1) Alternate wheat-fallow cropping; (2) stubble mulching; (3) chiseling; (4) diversions. With the use of these practices, the intercepted water infiltrates into the soil, helps control erosion, and is available for crop use. Most of these practices are presently established on dryland areas. However diversions are only being used on critical areas and some lands are not protected from water loss and erosion.

Methods of irrigation and water availability are shown on table 181. Methods vary from wild flooding to carefully designed border, dike, and sprinkler systems. The irrigation method used on a given field depends upon many factors including soil texture and depth, topography, crop grown, cost of water, opportunity to dispose of or reuse water, and amount of labor.

Table 181 - Water Availability and Irrigation Methods for Cropland, Subregion 4, 1966

Item	Idaho	Wyoming	Nevada	Utah	Total	Percent
			(1,000 acres)			
Water Source						
Streamflow	447.8	133.7	12.1	5.9	599.5	25
Ground Water	653.9	-	.3	-	654.2	27
Storage	1,155.6	.2	-	.9	1,156.7	48
Total	2,257.3	133.9	12.4	6.8	2,410.4	100
Area with Adequate Supply	1,910.1	36.7	5.5	1.1	1,953.4	81
Area with Inadequate Supply	347.2	97.2	6.9	5.7	457.0	19
Method of Irrigation						
Surface	1,805.5	121.1	12.4	6.8	1,945.8	81
Sprinkler	451.8	12.8	-	-	464.6	19

Source: Soil Conservation Service, C-NPRBS Data

Efficient use and operation of surface irrigation systems require good design and careful management by skilled operators. (SCS I-1451-7)

The water supply is adequate for the land that is irrigated from the Snake River. Streamflows are supplemented by approximately 4.5 million acre-feet of upstream storage. Tributaries to the Snake River and the nontributary streams on the north side of the Snake River Plain, however, are not so reliable and several areas are short of water. Surface water supplies come almost entirely from snowmelt, which are forecast before the planting season. Ground water is generally adequate for the land that is irrigated from this source. However, in some areas pumping has been restricted because of lowering water tables.

Drainage

Approximately 396,300 acres or 10 percent of the cropland has a drainage problem, mostly associated with irrigation (table 182). Of this amount, 94,000 acres would require group or project-type action to correct. The remaining areas could be corrected by individual action.

Sprinkler systems are used to irrigate steep or gravelly soil. This field of grass and legume on the Idaho-Wyoming border draws water from a community pipe system which delivers water from a mountain stream. Sprinkling pressure is obtained by gravity. (ORC-31-4)

Table 182 - Cropland Areas with a Wetness Problem, Subregion 4, 1966

Capability Class	Idaho	Wyoming	Nevada	Utah	Total
			(1,000 acres)		
II	14.0	-	-	-	14.0
III	139.1	-	8.0	-	147.1
IV	190.2	45.0	-	-	235.2
Total	343.3	45.0	8.0	-	396.3

Source: Soil Conservation Service, C-NPRBS Data

Drainage investigations in parts of the subregion show that more than 25 percent of the water diverted in the canals is lost by seepage. A direct relationship exists between the elevation of the water table and the start and finish of the irrigation season. In many areas where irrigated alfalfa, sugar beets, grain, and potatoes were originally grown, the land is now wet meadow or low quality saltgrass and foxtail pasture.

The drainage and high water table problem occurs primarily in five areas: Roberts, Southeast Blackfoot, Sterling Bench, Camas Prairie, and Rupert. Although several large drains have been constructed, the problem areas are gradually enlarging and generally becoming worse. The present status of drainage practices is shown in table 183.

Table 183 - Drainage Practices Applied to Cropland, Subregion 4, 1966

Item	Unit	Wyoming	Idaho	Utah	Nevada	Total
Conduits & Ditches	Miles	18	200	4	4	226
Structures	No.	2	21	4	-	27

Source: Soil Conservation Service Data

High water tables and sub-surface drainage problems restrict land use and crop production in several areas of the subregion. (I-1153-9)

Erosion and Sedimentation

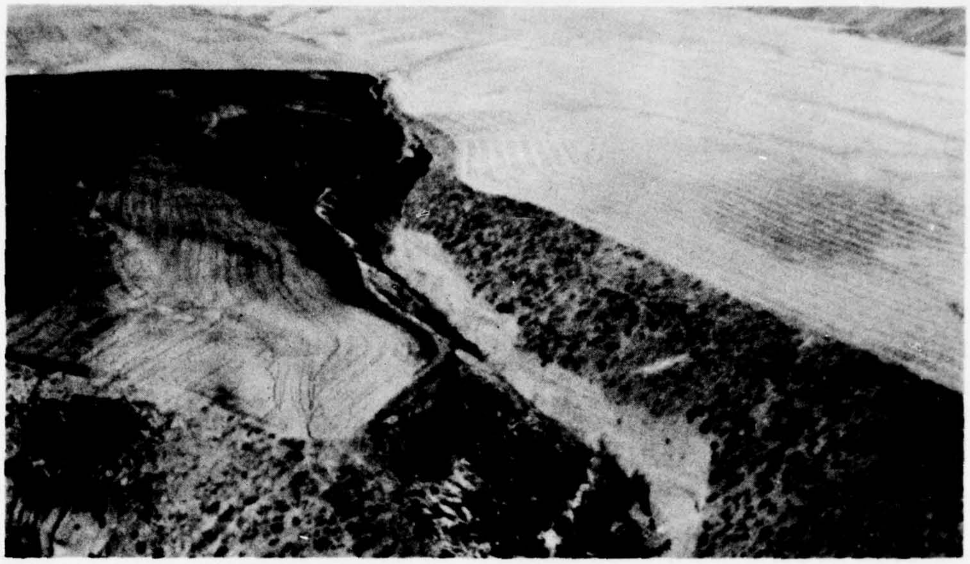
Erosion of the cropland is widespread and serious throughout the subregion. About 2,203,000 acres of cropland have an erosion potential (table 184).

Table 184 - Cropland Areas with an Erosion Potential by Capability Class, Subregion 4, 1966

Capability Class	Idaho	Wyoming	Nevada	Utah	Total
	1000 acres				
II	371	--	--	--	371
III	1,407	--	--	38	1,445
IV	364	19	4	--	387
Total	2,142	19	4	38	2,203

Source: Soil Conservation Service, C-NPRBS Data.

Erosion has increased noticeably the last 10 years with a severe gully pattern developing over much of the cropland. Many areas that were once farmed in large blocks are now cut into small fields by gullies too deep to cross with farm machinery. Present farming conditions and methods, including the use of large, fast-traveling farm machinery, are contributing to erosion and soil loss.

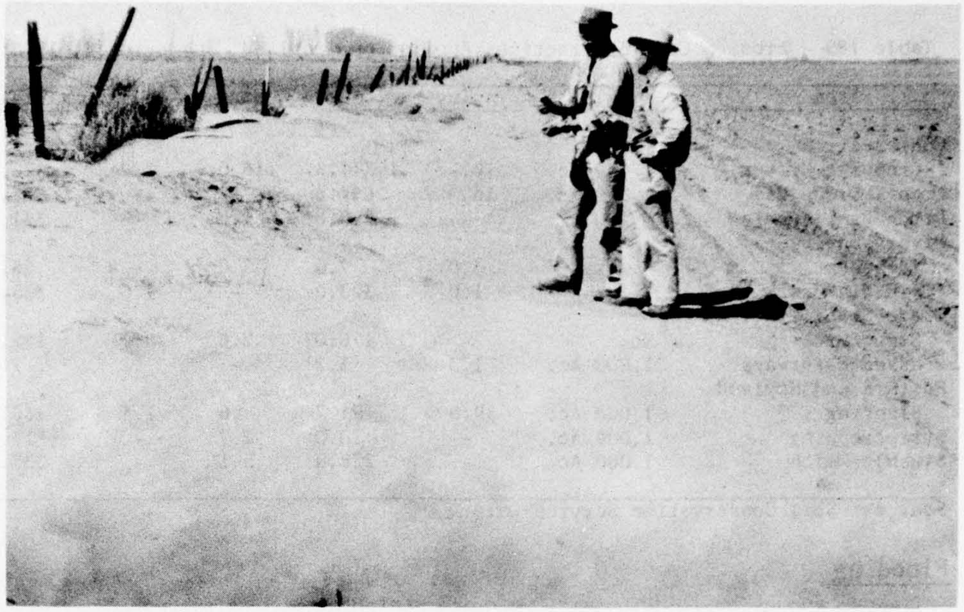


Improper tillage practices on dry farmland have accelerated erosion. Old ravines are extending themselves and new gullies are forming in the fields. (I-2292-9)

The most severe and damaging erosion occurs in the dryland areas where soils are formed in deep beds of wind deposited silt. A large portion has limited rainfall and is under a grain-fallow cropping system. Frozen ground during the runoff period prevents water from soaking into the soil and the surface erodes severely as it thaws. Summer storms of a cloud burst nature cause heavy damage to fallow fields. The erosion rate on the dry cropland averages approximately 5 to 10 tons per acre per year. However, erosion rates as high as 300 tons per acre have been measured on individual fields.

Much of the irrigated land is subject to erosion. In parts of the irrigated area the land is steep and the loessal soils erode when irrigation water is applied. Fields cropped to sugar beets, potatoes, corn, and beans are the most susceptible. Poor irrigation methods on steep land and erodible soil create a serious erosion problem. Generally, little erosion occurs in pasture and hay fields. There is some soil movement in grain fields, but it is usually not critical.

A new erosion and sediment problem is occurring in areas that have recently been developed by sprinkler irrigation. Thousands of acres of rough, sloping brush and dry cropland that formerly had a fair protective cover are being irrigated. The land is farmed without regard to contour or slope.



The sandy and silty soil moves readily with the wind. Proper tillage and management of crop residues can greatly reduce wind erosion. (I-1228-5)

Harvesting operations in the fall leave the row cropland bare and compacted. The soil profile is full of moisture from irrigation, and runoff from the land is much greater than before. The resulting flood water and the heavy sediment it carries are causing extensive damage to lower lying cropland that has been relatively free from these problems in the past. (Land that is steep and erodible, or is otherwise not suited for surface irrigation, should be left in permanent sod crops.)

Erosion has been controlled on the flatter land by planting grasses and legumes in a rotation with small grain to maintain soil structure and provide a protective cover for the land. Tillage practices such as fall chiseling and stubble mulching also protect the soil surface and increase water infiltration.

On the steeper land where the snowfall is heavy, structures are used to supplement the vegetative measures. Grassed waterways, diversions, terraces, and debris basins are used separately or in combination to help with water control. The present status of erosion control practices on cropland is shown in table 185.

Wind erosion is a serious problem throughout the subregion. Damage occurs mostly in the early spring when the fields are unprotected and the seedlings are easily damaged by wind blown particles. Conservation practices such as windbreaks, cover crops, crop residues, and rough tillage are used to protect the land.

Table 185 - Erosion Control Practices Applied on Cropland, Subregion 4, 1966

Item	Unit	Wyoming	Idaho	Utah	Nevada	Total
Conservation Cropping System	1,000 Ac.	19.7	1,341.4	10.0	1.2	1,372.3
Crop Residue Use	1,000 Ac.	16.7	844.8	.2	-	861.7
Ditch Bank Seeding	Miles	-	330.0	1.0	-	331.0
Diversions and Terraces	Miles	3.0	7.0	5.0	-	15.0
Field Windbreak	Miles	1.0	303.0	-	1.0	305.0
Grade Stabilization Structures	No.	-	175.0	2.0	10.0	187.0
Grassed Waterways	1,000 Ac.	1.3	1.2	-	.2	2.7
Pasture and Hayland Planting	1,000 Ac.	39.9	91.7	.6	1.4	133.6
Stripcropping	1,000 Ac.	-	10.8	2.7	-	13.6
Stubble Mulch	1,000 Ac.	-	228.0	5.3	-	233.3

Source: Soil Conservation Service Data.

Flooding

Over 7 percent of the cropland or 283,000 acres suffers damage from flooding. The damage occurs along the major rivers and tributaries and in some localized areas.

The flooding varies greatly in cause, patterns of flow, frequency, seasons of occurrence, areas affected, and amount of damages. The prime source of flood flows in most streams in the region, particularly those draining high elevation areas, is spring snowmelt. Rainstorms during the snowmelt runoff often add to the problem and produce high flood peaks in streams. At the lower elevations, late winter or early spring rains cause most flooding. Frozen ground conditions prevent infiltration and ground storage of water and are a major factor contributing to the flooding of these areas. Ice jams in the larger streams also contribute to the problem. Summer thunderstorms cause extensive damage almost yearly in some areas.

Land along the small streams and in the narrow valleys is normally cropped to hay and pasture and generally does not suffer extensive damage. In other areas, however, high producing land on which potatoes, sugar beets, grain, and alfalfa are grown is often damaged severely. According to Appendix VII, Flood Control, the estimated annual average rural flood damages are over $7.3 million, but this includes damages to roads, bridges, irrigation and drainage structures, and natural channels that are not cropland. The total estimated average annual flood damages are over $8.6 million.

Practices applied to safely remove excess water, stabilize channels, and prevent bank erosion and flooding are shown on table 186.

Flash floods erode the cropland and deposit sediment on fields, roads, and farmsteads. Most of such flooding can be controlled by proper land treatment. (I-2382)

Table 186 - Flood Protection Measures Applied on Cropland Areas, Subregion 4, 1966

Item	Unit	Wyoming	Idaho	Utah	Nevada	Total
Stream Channel Improvement	Miles	1	65	-	4	70
Streambank Protection	Miles	9	9	-	2	20
Dikes and Levees	Miles	2	49	Tr.	Tr.	51
Stream Channel Stabilization	Miles	10	3	-	4	17

Source: Soil Conservation Service Data.

Forest Land

Forests cover 4.3 million acres, or 19 percent of the total land area in the subregion. About 93 percent is in public ownership and 7 percent is private. Of this, 58 percent is commercial forest land and 42 percent is noncommercial. The commercial area supports nearly 15.6 billion board feet of merchantable timber: 98 percent on public land and 2 percent on private. In 1964, 74 million board feet were harvested from these areas, furnishing employment for some 400 workers. The noncommercial forest is located principally in the high alpine areas approaching timberline, or involves commercial forest withdrawn from commercial use. Activities such as logging, road construction, or others that disturb vegetative cover, are limited here. Grazing is an important use of both the commercial and noncommercial forest areas in parts of the subregion.

Although only 19 percent of the subregion is forested, over 52 percent of the annual runoff originates here. These watersheds provide domestic water for 46 percent of the urban population and are a major source of irrigation water.

The forest lands of the subregion are generally in good hydrologic condition, with sediment yields low overall. Average sediment production is slightly over 260 acre-feet per year, representing about 8 percent of the total from the subregion (table 187). Localized severe soil movement is common and causes most of the sediment.

Table 187 - Present Sediment Yield, Forest Land, Subregion 4

Sediment Yield Category	Acres (1,000)	Percent	Annual Sediment Yield: Acre-feet per Square Mile	Total Acre-feet	Percent
Very low	3,276.8	76	0.02 - 0.1	102	39
Low	1,020.1	24	0.1 - 0.2	160	61
Medium	--	--	0.2 - 0.5	--	--
High	--	--	0.5 - 1.5	--	--
Very high	--	--	1.5 - 4.0	--	--
Total	4,296.9	100		262	100

Source: Derived from figures 25 and 26.

Over 75 percent of the forest land is in the very low sediment yield category where erosion results primarily from natural causes. The remaining 25 percent is in the category where land use activities have caused erosion. It is on these areas that the present watershed rehabilitation work is directed.

Watershed Protection

Timber harvest procedures are limited to tree selection and partial cut practices. Yarding is done by mobile cranes except on gentle terrain where bulldozers operate. Skid trails are cross-drained and seeded and debris is removed from major draws and water courses.

Most roads have permanent drainage structures and heavily used routes are gravel surfaced. Standards have been developed for road location and design to reduce soil movement and give adequate opportunity for water disposal. In many cases, exposed cutbank and fill slopes are seeded to grass to reduce soil movement.

Reforestation measures include planting, direct seeding, and natural seeding, usually preceded by site preparation such as burning or scarification. Advanced reproduction is protected during falling and yarding operations by on-the-ground controls. A summary of the harvest practices and protection activities is outlined on table 188.

Table 188 - Average Annual Harvest Activity, Subregion 4

	Unit	Public	Private	Total
Harvest Area	Ac.	21,000	3,000	24,000
Area Reforested 1/	Ac.	3,000	200	3,200
Slash Disposal Area	Ac.	4,500	500	5,000
Disturbed Area Treated 2/	Ac.	3,200	--	3,200
Harvest Road Required	Mi.	105	15	120
Harvest Road Treated 3/	Mi.	90	--	90

1/ Includes planting, seeding and site preparation. Balance adequately stocked or requires no regeneration work.
2/ Includes seeding, mulching, debris removal and cross-draining skidroads and logging areas.
3/ Cut and fill stabilization only.

Watershed Rehabilitation

About 24 percent of the forest land has erosion problems that produce about 160 acre-feet of sediment per year (table 187). Most of this results from water movement down abandoned roads, through placer mining, and across areas logged-over and overgrazed years ago. The gully in the accompanying photograph resulted from poor road location and inadequate drainage. The photo indicates a lack of concern for soil and water resources.

Gully and sediment deposition from waterflow on abandoned road. (Forest Service)

Current rehabilitation activities include gabion construction; riprap; willow planting; revetments and channel clearing as streambank rehabilitation measures; and trenching, backfilling, seeding, and planting as strip mine rehabilitation measures. Abandoned roads are usually cross-drained, pitted and/or seeded to reduce soil movement. Rehabilitation practices accomplished on forest lands are listed in table 189. This does not, however, include nonrecurrent fire rehabilitation measures.

Water Yield Improvement

Water yield improvement programs are new in the subregion. So far, they have been limited to national forest areas on an experimental basis.

Table 189 - Average Annual Accomplishment, Watershed Rehabilitation Practices on Public Forest Land, Subregion 4

Practice	Unit	National Forest 1/	Public Domain	Indian Lands	State Lands
Sheet Erosion Control	Ac.	650	--	--	--
Gully Stabilization	Mi.	3	--	--	--
Stream Clearance & Stabilization	Mi.	6	--	--	--
Existing Road & Trail Rehab. 2/	Mi.	25	1	--	--
Reservoir Protection	Ac.	--	--	--	--

1/ Average of period 1964-66.
2/ Includes abandoned roads.
Source: Data furnished by agency as listed.

Rangeland

Subregion 4 contains 13.6 million acres of rangeland which accounts for 60 percent of the total land area (table 178). The Federal Government has jurisdiction of 10.4 million acres or 77 percent of the range, including 5.8 million acres administered by the Bureau of Land Management, 3.3 million acres by the Forest Service, and 1.3 million acres by other Federal agencies. Other public range included 884,000 acres in state and municipal ownership (7 percent of the total). About 2.2 million acres or 16 percent of all range are privately owned. Rangeland is discussed in Appendix IV, Land and Mineral Resources.

Present rangeland condition and capacity is shown on table 190. Sagebrush is the predominant cover on 75 percent of the range, grass and forbs on 21 percent, and other brush and shrubs on 4 percent. Although private interests control only 16 percent of the total range acreage, they account for 20 percent of the total grazing capacity (6 acres per AUM on private lands, compared to 7.6 acres per AUM on public lands).

Range deterioriation caused mainly from overgrazing by livestock and big game as well as wildfires was clearly in evidence by the 1920's and 1930's. Most watershed measures and practices since then have been directed to preventing further deterioration and to rehabilitating severely damaged areas. These efforts have not been intensive enough to stop deterioration in certain areas. Excessive grazing use has been reduced on about 10.9 million acres of rangeland in this subregion (80 percent of all rangeland). Yet at the present time, only 19 percent of the range is in good condition, and 18 percent remains in poor condition with deficient vegetative cover and considerable accelerated erosion.

Table 190 - Rangeland Condition and Capacity, Subregion 4, 1966

Range Type and Condition	Public Acres (1,000)	Public AUMs (1,000)	Private Acres (1,000)	Private AUMs (1,000)	Total Acres (1,000)	Total AUMs (1,000)
Grassland						
Good	231.5	62.6	54.5	14.7	286.0	77.3
Fair	1,239.4	190.7	55.0	8.4	1,294.4	199.1
Poor	131.5	9.4	12.3	.9	143.8	10.3
Seeded Range 1/	784.3	261.4	367.9	122.7	1,152.2	384.1
Total	2,386.7	524.1	489.7	146.7	2,876.4	670.8
Sagebrush						
Good	424.9	70.8	594.4	99.1	1,019.3	169.9
Fair	6,245.2	743.5	889.8	105.9	7,135.0	849.4
Poor	1,856.4	116.7	182.2	11.5	2,038.6	128.2
Total	8,526.5	931.0	1,666.4	216.5	10,192.9	1,147.5
Other Brush						
Good	20.9	3.5	27.8	4.6	48.7	8.1
Fair	122.8	15.3	23.1	2.9	145.9	18.2
Poor	265.3	15.8	26.6	1.6	291.9	17.4
Total	409.0	34.6	77.5	9.1	486.5	43.7
Total						
Good 2/	1,461.6	398.3	1,044.6	241.1	2,506.2	639.4
Fair	7,607.4	949.5	967.9	117.2	8,575.3	1,066.7
Poor	2,253.2	141.9	221.1	14.0	2,474.3	155.9
Grand Total	11,322.2	1,489.7	2,233.6	372.3	13,555.8	1,862.0
Percent Distribution	83.5	80.0	16.5	20.0	100.0	100.0
Average AC/AUM	7.6		6.0		7.3	

1/ Seeded range acreage was combined with good condition grassland in Appendix IV.
2/ Includes seeded range.
Source: C-NP Appendix IV, Subregion 4. Range production has been estimated for the C-NP Study from representative situations observed and recorded in on-site surveys. Estimates are based on perennial vegetation and proper utilization.

Gully erosion is common in the alluvium of the valleys, and sheet erosion is often evident at higher elevations. The average annual sediment yield from rangeland is 1,917 acre-feet (table 191), 62 percent of the sediment yield from all lands in the subregion. About 1,056 acre-feet or 55 percent of the rangeland sediment yield comes from 4.4 million acres or 32 percent of the land in the "Low" and "Medium" sediment yield categories (the highest yield categories in this subregion due to the precipitation pattern and high intake soils). Higher sediment yield areas are located southeast of American Falls and south of Pocatello where the average annual rate is .35 acre-foot per square mile. Most rangeland in the southern part has an average annual rate of .15 acre-foot per square mile, as do areas in Camas and Blaine counties of Idaho, and scattered areas in eastern Idaho and Wyoming.

Table 191 - Sediment Yield from Rangeland, Subregion 4, 1966

Sediment Yield Categories[1/]	Grassland	Sagebrush & Shrubs	Total	Percent
		Rangeland Acreage (1,000 Acres)		
Very Low	2,283.8	6,897.7	9,181.5	68
Low	551.0	3,723.5	4,274.5	31
Medium	41.6	58.2	99.8	1
High	--	--	--	--
Very High	--	--	--	--
Total	2,876.4	10,679.4	13,555.8	100
		Annual Sediment Yield (Acre-Feet)		
Very Low	214	647	861	45
Low	129	873	1,002	52
Medium	23	31	54	3
High	--	--	--	--
Very High	--	--	--	--
Total	366	1,551	1,917	100

1/ Very Low through Very High Categories represent generalized range areas on which annual sediment yield per square mile averages .06, .15, .35, 1.00, and 2.75 acre-feet, respectively.

Source: Derived from figures 25 and 26.

Measures and Practices for Watershed Protection

Most rangeland measures and practices shown on table 192 for watershed protection and improvement through 1965 have multiple objectives and benefits. Many of them serve management objectives other than improving the watershed. The major emphasis of rangeland watershed protection has been directed to: (1) revegetation by seeding and brush control; (2) expanded fire protection programs; (3) increased management of livestock through the development of management plans, fencing, and the reduction of overgrazing; and (4) water development for livestock and wildlife to provide better grazing use distribution.

Cover improvement and soil stabilization practices have been applied on a combined total of about 2.3 million acres. An estimated 1.2 million acres have been revegetated, primarily by grass seeding, and brush was controlled on some 973,000 acres. About 35 percent of the benefit of these practices was for erosion and water quality control objectives, 20 percent for water conservation, and 45 percent

Table 192 - Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, Subregion 4, 1966

Measures & Practices	Units	Land Ownership			Watershed Purposes 1/			
		Public 2/	Private	Total	(1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	784,200	367,900	1,152,100	-	x	x	-
Brush Control	Acres	472,200	500,800	973,000	-	x	x	-
Weed Control	Acres	97,400	19,200	116,600	-	x	x	-
Fertilizing	Acres	250	50	300	-	x	x	-
Conversion of tree cover to grass	Acres	500	100	600	-	x	x	-
Contouring, Pitting, Furrowing	Acres	7,800	1,500	9,300	-	x	x	-
Stream & Bank Stabilization	Acres	9	2	11	-	x	x	x
Waterspreading	Acres	-	7,300	7,300	-	x	x	x
Irrigation	Acres	100	20	120	-	x	-	-
Water Oriented Land Management Practices								
Livestock Control Fences	Miles	163,200	32,200	195,400	-	x	x	-
Reducing Excessive Grazing Use	Acres	9,064,700	1,785,800	10,850,500	-	x	x	-
Livestock & Game Water Facilities	Number	1,300	2,800	4,100	-	x	x	-
Road Stabilization	Miles	204	NA 3/	NA 3/	x	x	x	x
Water Control Structures								
Ponds & Small Reservoirs	Number	1,000	200	1,200	-	x	x	-
	Acre Ft.	24,500	4,800	29,300	-	x	x	-
Detentions	Number	100	30	130	-	x	x	-
	Cu. Yds.	92,700	18,300	111,000	-	x	x	-
Check Dams (Gully Plugs)	Number	2,500	500	3,000	-	x	x	x
	Cu. Yds.	20,300	4,000	24,300	-	x	x	x
Dikes	Lin. Ft.	126,100	24,800	150,900	-	x	x	x
Diversions	Number	-	170	170	x	x	x	x
	Cu. Yds.	-	688,000	688,000	x	x	x	x

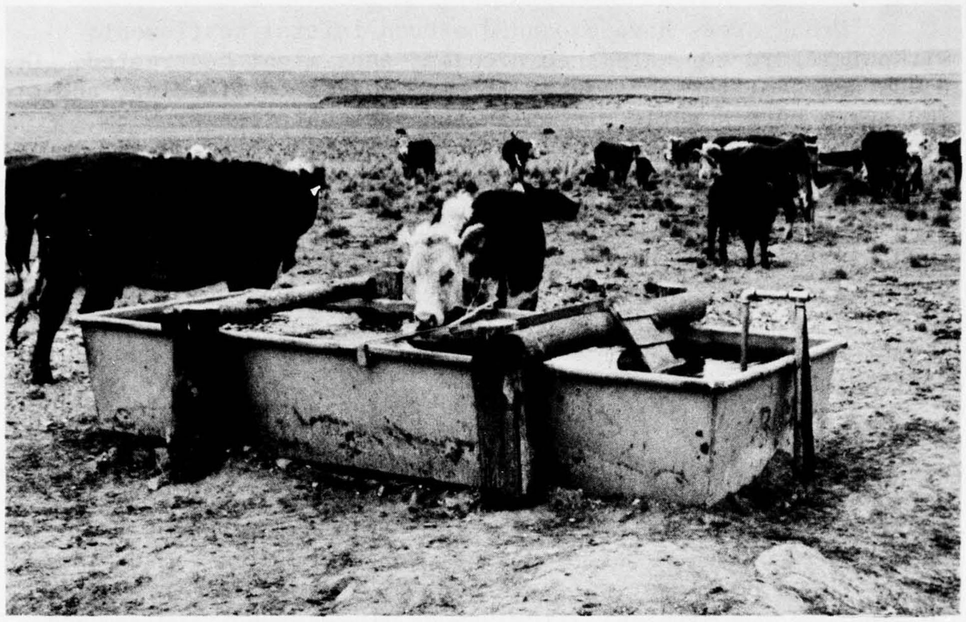
1/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4-Flood Debris Control.
2/ Includes Federal, State, County, and Municipal Ownership.
3/ Not Available.
Source: Data collected from land management agencies specifically for the C-NP Study.

for other management purposes including forage production. Other significant practices included 116,600 acres of weed control, contouring of 9,300 acres and waterspreading on 7,300 acres. Waterspreading of spring runoff to rangeland with deep soils has increased forage and protective cover while conserving water that would otherwise have been lost.

Livestock grazing use has been reduced or adjusted to the current grazing capacity of the range on an estimated 10.9 million acres. Of importance in this reduction has been the development of grazing management systems providing sufficient rest periods for natural revegetation of range cover. To attain better distribution and more uniform utilization by game and livestock, about 4,100 livestock and game watering facilities have been developed and an estimated 195,000 miles of livestock control fence constructed.

Measures to control runoff and reduce erosion have been included in the maintenance and improvement of about 200 miles of public access roads and trails, as well as a number of miles on the private range.

Water control structures have been developed to reduce erosion, control debris, and conserve early season runoff for subsequent livestock, recreation, and fish and wildlife use. These include about 1,200 ponds and small reservoirs with a



Typical livestock and game watering trough developed to provide more uniform livestock distribution and fuller use of water supplies on favorable range areas. Source of water supply for this trough is some distance away and is protected. (Bureau of Land Management)

capacity of 29,300 acre-feet, 300 diversion or detention dams, 3,000 small check dams, and an estimated 29 miles of dikes.

Other Land

Other land in this subregion amounts to 1.0 million acres, which is about 5 percent of the land area. The acreage of other land categories is shown in table 193.

Table 193 - Other Land Areas, Subregion 4

Item	Idaho	Wyoming	Nevada	Utah	Total	Percent
			(1,000	acres)		
Small Water	11.6	15.0	1.3	.1	28.0	2.7
Roads & Railroads	70.9	8.7	1.7	.2	81.5	7.8
Farmsteads, Urban, Industrial, & Misc.	96.0	10.6	.2	.1	106.9	10.2
Barren Land	550.0	276.0	2.6	2.8	831.4	79.3
Total	728.5	310.3	5.8	3.2	1,047.8	100.0

Source: Appendix IV, Land and Mineral Resources.

Urban areas have expanded around initial settlements without regard for watershed problems that might be created. Over 8,000 acres of these urban areas are subject to flooding, and over 700 acres have a serious erosion and sedimentation problem.

Roads and railroads have been built where topography was most favorable and construction costs the most reasonable. There have been few hazards connected with the construction of mainline roads and railroads, although flood areas have to be avoided. Secondary roads, particularly those on steep unstable mountain soils, have caused excessive stream siltation. Cut and fill slopes have been stabilized on most of the interstate and primary state highways.

Most of the 831,400 acres of barren land consist of exposed basalt lava flows on the Snake River Plain. Some of this barren area is used for recreational purposes and geologic instruction as at Craters of the Moon National Monument, but, otherwise, most have little present economic value. Sand dune areas in the northeast part of the Snake River Plain are subject to wind erosion with resulting damage to adjacent cropland and developed areas. An estimated 4,200 acres of dune and blowout stabilization practices have been installed in this subregion. These include the installation of special fencing, planting special grasses and shrubs or other measures necessary to stabilize and control dunes and blowouts. Barren rock and alpine areas in the mountains are valuable for water yield, wildlife habitat, recreation, esthetic values, and as a vast storage reservoir of ice and snow.

FUTURE NEEDS

This section of the report identifies needs for watershed protection and rehabilitation to meet present watershed problem areas as affected by projected changes in population and land use to the year 2020. Population is expected to more than double from 277,000 in 1966 to 576,000 in 2020 with an accompanying demand for more urban, industrial, and recreational land areas. Table 194 shows the projected change in cover and land use. To meet increased food and fiber production requirements, cropland will expand by 79,000 acres. Other land, principally urban and special use areas, will increase about 79,000 acres, and large water areas (reservoirs) will utilize 139,000 additional acres. These increases will be offset by a 91,000 acre decrease in forest land and 206,000 acres less of adjacent rangeland areas.

Table 194 - Projected Change in Cover and Land Use, Subregion 4

Item	1966	1980	2000	2020
		(1,000 acres)		
Cropland	3,781	3,906	3,872	3,860
Forest Land	4,297	4,273	4,254	4,206
Rangeland	13,556	13,362	13,355	13,350
Other Land	1,048	1,069	1,097	1,127
Total	22,682	22,610	22,578	22,543

Source: C-NPRBS Projections.

Cropland

The major problems associated with cropland, are water shortage, irrigation water management, salinity, incomplete drainage, erosion, and flooding. Changes in cropping patterns and methods will affect these problem areas. Irrigated cropland acreage is expected to increase approximately 709,000 acres, while dry crops will use some 630,000 acres less by 2020 (table 195).

Table 195 - Projected Trends in Dry and Irrigated Cropland, Subregion 4

Cropland	1966	1980	2000	2020
		(1,000 acres)		
Dry Farmed	1,371	1,064	928	741
Irrigated1/	2,410	2,842	2,944	3,119
Total	3,781	3,906	3,872	3,860

1/ Approximately 97 percent of the total area projections shown in Appendix IX, Irrigation.
Source: Appendix VI, Economic Base and Projections.

Water Conservation

Agricultural production increases will be mostly in the irrigated cropland areas, primarily because large areas of soils suitable for irrigation are available, and water can be supplied from additional storage and by pumping from wells.

More efficient irrigation management is needed by lining canals to reduce seepage and by leveling land to distribute surface irrigation water more uniformly with less labor. Sprinkler irrigation is increasing because this method can apply water efficiently

on rough land and it requires much less skill than does surface irrigation. It is estimated that one-third of the land now irrigated by flood methods will be shifted to sprinkler systems by 2020. Essentially all of the new developments will be by sprinkler.

The anticipated increase of irrigated land and the supplying of full irrigation to presently water-short areas will increase the consumption of agricultural water. Table 196 shows the probable trend in method of irrigation. The projected shift to sprinkler systems is expected to increase irrigation efficiency from the present 30 percent to 50 percent by 2020. Of the 2,410,400 acres presently irrigated, 438,200 acres do not have a full season water supply. Considering the time of shortage and the climates of the various water-short areas and considering the present efficiency, approximately 2,350,000 acre-feet of additional water would be required to provide for a full seasonal water supply. Water is available for much of this area by storage or by developing ground water. It is probable that part of the area will not be developed because the added production will not pay the cost of developing a full season water supply.

Table 196 - Projected Cumulative Trend in the Method of Irrigation on Cropland, Subregion 1

Item	1966	1980	2000	2020
		(1,000 acres)		
Sprinkler Systems	464	896	1,360	1,898
Flood Systems	1,946	1,946	1,584	1,221
Total	2,410	2,842	2,944	3,119

Source: Soil Conservation Service, C-NPRBS Data

After all diversions and uses of water, approximately 6 million acre-feet of water leave the subregion each year. This is available for irrigation if the necessary physical facilities, legal arrangements, and water right exchanges can be made.

Drainage

Approximately 396,300 acres of cropland are, to some degree, in need of drainage (table 197). Most of the subsurface drainage problems are related to irrigation, and they will diminish as irrigation practices improve. New drainage problems will probably appear when some of the potentially irrigable lands are developed. Perched water tables and toe-of-the-slope wet spots will form in a

few places in spite of careful irrigation system design and management. Large-scale drainage problems will develop in valleys with limited outlets if the ground-water systems are not developed when water is brought in from outside sources.

Table 197 - Cumulative Cropland Areas Needing Drainage, Subregion 4

Item	1966	1980	2000	2020
		(1,000 acres)		
Wet Area	396	427	440	458
Projected Accomplishments	71	130	158	195
Remaining	325	297	282	263

Source: Soil Conservation Service, C-NPRBS Data.

Erosion and Sedimentation

Erosion by both wind and water and the resulting siltation and sedimentation are a serious problem on 886,000 acres of cropland (table 198). More controls will be needed to regulate runoff from the agricultural lands. Management practices and structural measures properly adapted to the soil, slope, and land use will reduce erosion and sedimentation to a more acceptable level. Of the 2,203,000 acres of cropland having an erosion problem, as much as 40 percent may require some type of project action to correct.

Table 198 - Cumulative Cropland Areas Needing Erosion Control, Subregion 4

Item	1966	1980	2000	2020
		(1,000 acres)		
Erosion Potential	2,203	2,473	2,654	2,894
Projected Accomplishments	573	1,023	1,385	1,865
Remaining	1,630	1,450	1,269	1,029

Source: Soil Conservation Service, C-NPRBS Data.

Flooding

Flood protection is needed for 283,000 acres of cropland. Most of the flooding is runoff from higher elevation rangeland caused when rapid snowmelt and rain occur on frozen soil. While some can be controlled by reservoir storage and channel work, much

can be corrected only by reducing runoff from the watershed. Many of the treatment and management practices which will benefit cropland will also reduce the flood runoff. Complete flood protection for cropland is not economical at present, but greater protection will be justified as the land is used more intensively.

Forest Land

The forest industries of the subregion will require an estimated 42 million cubic feet of raw material per year by the year 2020. This volume will be produced essentially on the 2.5 million acres of commercial forest land projected to remain in timber production through this period. This amounts to 17 cubic feet per acre per year. Present forest yields are 17 cubic feet per acre, pointing out that increases are necessary if full industrial demands are to be met by 2020. Restocking, fertilization, thinning, and release are the principal management practices that will be employed.

Potential erosion hazard has been evaluated for the forest lands of the subregion. This is the potential if proper watershed protective measures are disregarded. Without this consideration, present yields could be expected to increase almost 17 times (figure 27 and table 199).

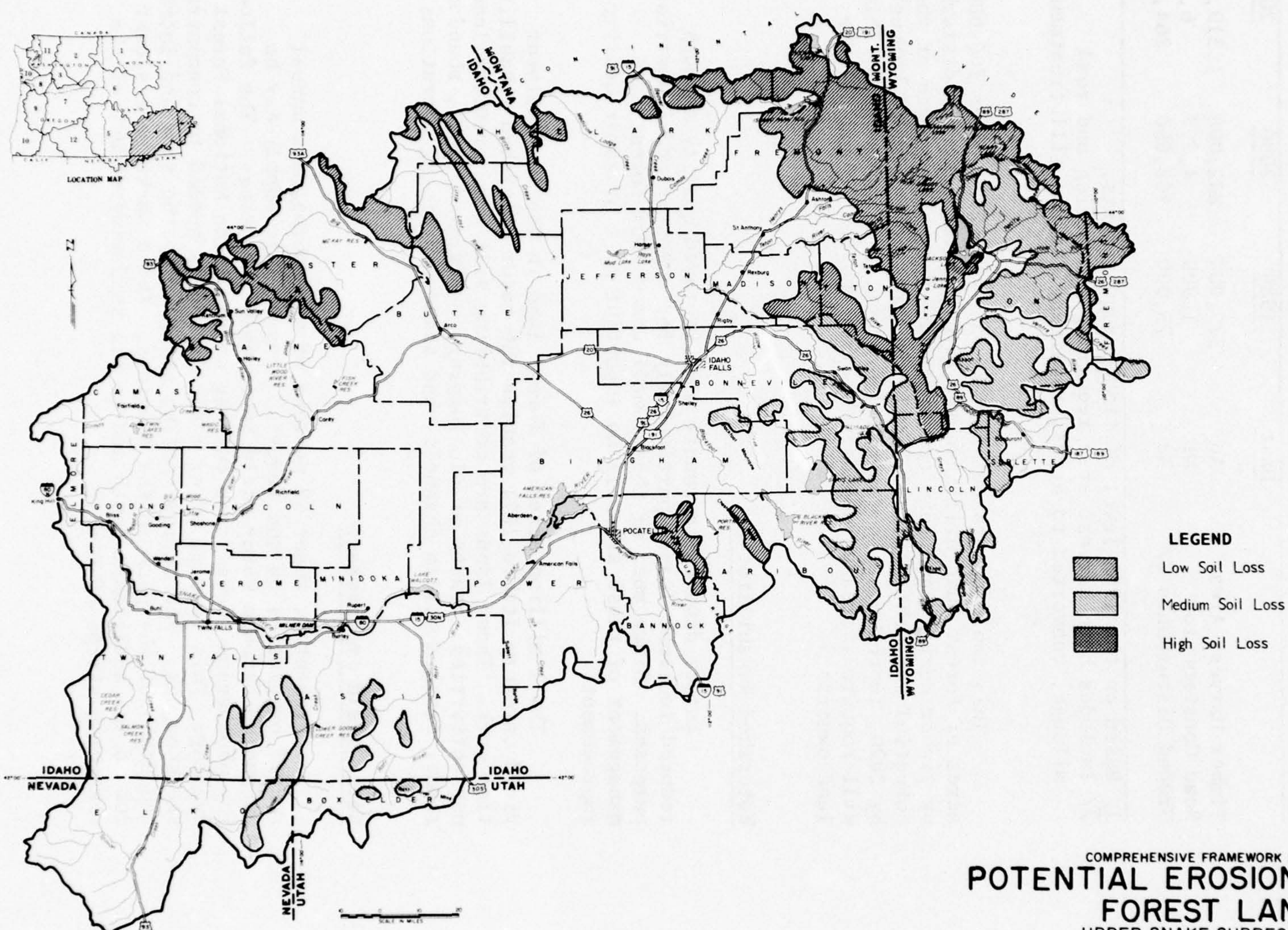
Table 199 - Potential Sediment Yield Without Protective Measures, Forest Land, Subregion 4

Soil Loss Category	Acres (1,000)	Percent	Acre-feet per Square Mile per Year	Total Acre-feet per Year
Low	2,535.0	59	less than 0.2	555
Medium	1,761.9	41	0.2 - 1.5	3,854
High	--	--	more than 1.5	--
Total	4,296.9	100		4,409

Source: Soil Survey Data & Interpretations, Forest Service, Region 4.

Watershed Protection

In order to meet the increased wood fiber requirements, the current timber harvest and road construction program will need to be accelerated, particularly the road construction phase. Activities resulting from this acceleration are projected on table 200.



COMPREHENSIVE FRAMEWORK STUDY

POTENTIAL EROSION HAZARD FOREST LAND

UPPER SNAKE, SUBREGION 4

1968

FIGURE 27

Table 200 - Projected Cumulative Timber Harvest Activity, Forest Land, Subregion 4 1/

	Unit	1980	2000	2020
Timber Harvest Area	Ac.	375,000	842,000	1,319,000
Road Construction	Mi.	1,900	4,200	6,600
Ground Disturbance 2/	Ac.	75,000	168,000	264,000

1/ Based on the 1965 level of timber requirements.
2/ Includes both harvest area requiring protection and road mileage, converted to acres, requiring cut and fill treatment.

This table points out that by the year 2020, over 260,000 acres of forest land will have the ground cover severely disturbed by timber harvest and road construction--the major source of the potential sediment. With 1.3 million acres coming under harvest by 2020, improvement in watershed protection is paramount. This will require increased emphasis by both the public and private land owners.

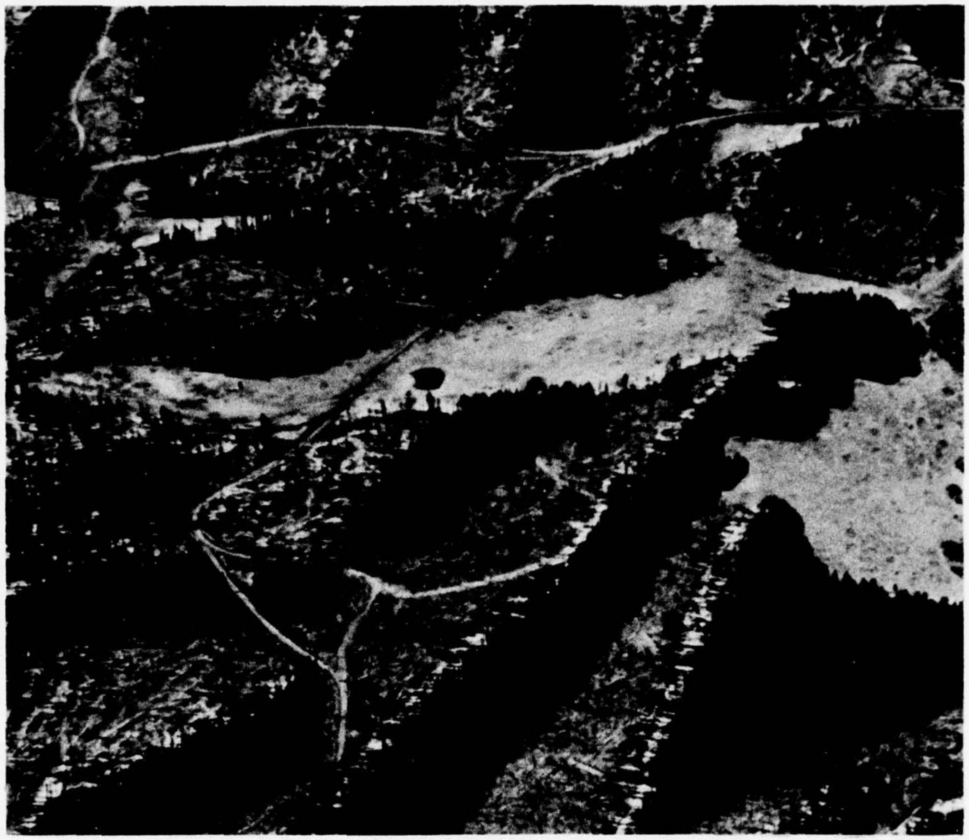
Watershed Rehabilitation

Future demands on runoff mean improved quality through reduced sediment loads, particularly for domestic and industrial purposes. Since much of this runoff comes from forest land, management of these areas is an important part of water quality improvement.

The 1 million acres of forest land in the low sediment yield category (table 187) require the major watershed rehabilitation work. These lands are contributing silt from previous land use activities, tracts of old logging, overgrazed range, abandoned roads, damaged stream channels, and abandoned mining operations.

Water Yield Improvement

Presently, about 52 percent of the subregion's annual runoff originates on the forested areas. This supply may be augmented through water yield improvement practices. The following photograph shows strip cutting on the Teton National Forest in Wyoming. This type of cover manipulation is needed to concentrate the snowpack. The narrow cutting strips trap the snow and increase the depth of the pack in the openings. These packs melt slower due to the additional depth and to the shadowing effect of the remaining strips of timber.



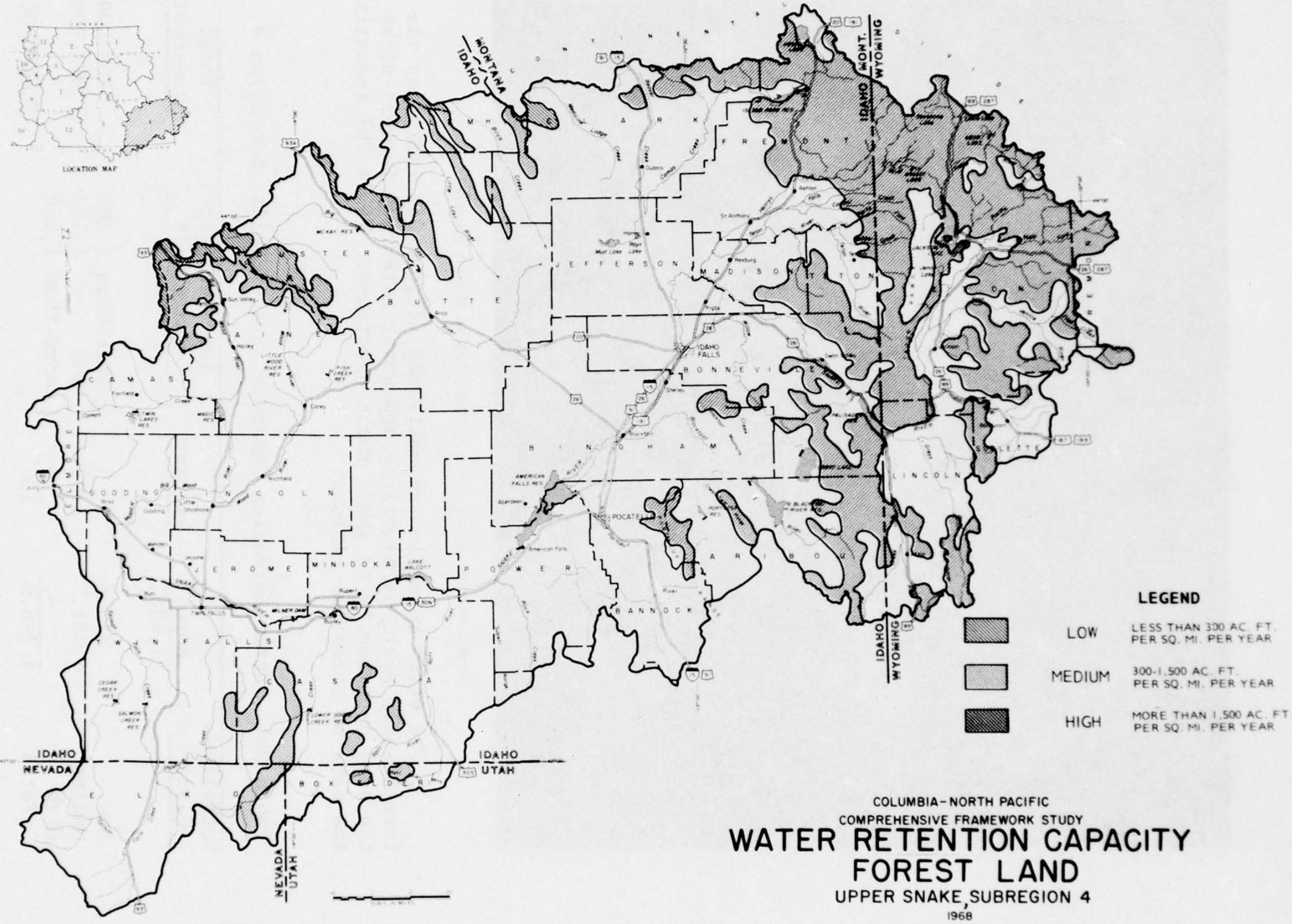
Strip cutting on the Teton National Forest. (Forest Service)

The water retention capacity map (figure 28) indicates the forest soils where permeability and water retention factors offer the best opportunity to apply these practices. Table 201 summarizes the data by retention classes.

Table 201 - Water Retention Capacity, Forest Soils, Subregion 4

Retention Class	Acres (1,000)	Percent	Acre-Feet per Square Mile	Total Acre-Feet
Low	215.4	5	less than - 300	100,000
Medium	4,081.5	95	300 - 1,500	2,550,000
High	-	-	more than 1,500	-
Total	4,296.9	100		2,650,000

Source: Soil Survey Data and Interpretations, Forest Service, Region 4.



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

WATER RETENTION CAPACITY FOREST LAND

UPPER SNAKE SUBREGION 4

1968

FIGURE 28

Rangeland

Rangeland watershed needs include measures to resolve present watershed problems and to protect range resources throughout projected changes in land and resource use. Erosion and sedimentation is a significant problem on 1.5 million acres, drainage problems exist on 126,000 acres, and flooding is a particular problem on 86,000 acres. 1/ The average annual rangeland sediment yield is about 1,917 acre-feet, more than half of which is produced from less than a third of the total land.

Projected Use of Range Resources

Substantial rangeland areas are used in support of the range livestock industry. These lands currently provide forage that produces an estimated 12.7 percent of the total beef and sheep production in this subregion. In 1964, beef and veal production amounted to 236.2 million pounds. This is expected to increase to 677.6 million pounds or 187 percent by 2020. Sheep and lamb production of 55.9 million pounds in 1964 is expected to increase 142.9 million pounds or 156 percent by 2020. (3) Future range forage production must be increased to the extent possible commensurate with proper land management and resource utilization, although total rangeland acreage is expected to decline by about 206,000 acres or 1.5 percent. Also, more attention must be directed to protection of critical wildlife habitat and to increase recreational demands on range areas.

Watershed Needs

Through 1965, about 1.6 million acres of rangeland had received land treatment for erosion and sedimentation control with lesser flood control and drainage objectives. This includes most of the measures and practices for cover improvement and soil stabilization given in table 192, along with accomplishments in road stabilization as adjusted for multiple practices on the same land. An additional 1.9 million acres will require treatment by 1980, 3.5 million acres by 2000, and 4.5 million acres by 2020. A significant feature of the watershed in this subregion is the Snake River aquifer. Large amounts of overflow sometimes cause severe sheet and gully erosion when there are late winter or early spring wet periods with snow on frozen soil, preventing adequate infiltration. Reservoir storage is inadequate to accommodate this runoff. Water control structures need to be developed to hold back the overflow and allow percolation into the soil and subsequently into the aquifer.

Livestock grazing use has been reduced or adjusted to the grazing capacity of the range on about 10.9 million acres, and

1/ Soil Conservation Service, C-NPRBS data.

special fire control practices have been initiated where required. Other measures for improved livestock distribution and control include development of stock and game water facilities and construction of control fences. Similar protection and management practices should be extended to an additional 2.5 million acres by 1980, and 2.6 million acres by 2000 and 2020. Watershed improvement should be accomplished by improved and more intensive management in preference to more costly construction measures which also cause greater disturbance to the environment and wildlife habitat. More information is needed on the relative importance of big game and domestic livestock and their competing use of range forage. Increased emphasis on fish and wildlife habitat, and recreational use of rangeland emphasize requirements for more comprehensive range management to meet competitive demands for range resources while providing adequate watershed protection.

By 1980, an estimated 165 miles of streams and waterways in range areas will require stream channel clearance and improvement, or efforts to improve water quality. An additional 165 miles will need attention by 2000, and 297 miles by 2020. More consideration must be given to water quality standards and control. Sedimentation levels as well as other chemical constituents of water must be established. Deficient quality areas must be identified and specific measures determined to improve water quality in conjunction with other range management objectives.

In conjunction with land treatment for erosion and sediment control, considerable streambank stabilization is needed. Less than a mile of bank stabilization was reported through 1965. This includes the stream and bank stabilization acreages reported in the "Present Status" section with conversion to miles on the basis of 40 acres per mile. Future needs include an additional 390 miles along streams or reservoirs by 1980, 788 miles by 2000, and 1,195 miles by 2020.

About 29 miles of dikes have been constructed in rangeland areas to help provide flood control and prevent damage from sediment and debris. An additional 2 miles will be needed by 1980, 7 miles by 2000, and 11 miles by 2020.

Other Land

Most soil and water problems on other land are not critical at the present time, but future changes in land use will continuously create new problems. These problems will result from land use changes needed by the increased population. Problems can be minimized by prudent planning, proper care, and orderly changes.

The acreage in other land is expected to increase from about 1,047,800 acres in 1966 to 1,127,000 acres in 2020, an increase of 8 percent (table 194). Most of the increase will be required to accommodate the projected 298,800 population increase, providing space for urban expansion, industrial growth, and areas for disposing of municipal and industrial waste. Additional lands for these uses will come from adjacent cropland and rangeland.

More efficient water management practices are required in the irrigation of lands in urban and suburban areas and along roadsides, which are projected to increase from about 75,000 acres to an estimated 91,000 acres by 2020.

Some of the new urban developments will occur on land which floods occasionally. The roofs and paved streets of the new development areas will increase the storm runoff, so flood protection will be needed on an estimated 4,000 acres. Erosion control will be needed on all of the land disturbed by building and road construction, and special measures will be needed to avoid serious sedimentation of nearby areas. Protection is needed for 8,200 acres of presently flooded urban area. Most of the flooding is from streams overflowing their banks. Another problem involves the dry sand areas north of the Snake River Plains. The dunes shift incessantly with the prevailing winds, covering roads, filling irrigation ditches, and burying productive cropland and rangeland. Present inventory indicates some 185,000 acres need protection to reduce this problem.

Considerably more study is required of areas in the other land category to properly identify and present future needs.

MEANS TO SATISFY NEEDS

Land measures and watershed protection practices to meet future needs are presented for cropland, forest land, rangeland, and other land. Frequently, necessary action in one of these land use categories will resolve problems in others, and a number of requirements in the upper watersheds are designed to resolve or reduce downstream problem areas.

Often the most effective means to satisfy future watershed needs is to apply measures and practices by cooperative efforts of the land owners. Of the 141 watersheds in this subregion, 99 have a complexity of problems which will require coordinated planning and development efforts. These are shown on table 202 by type of problem and time period. Location of these areas is shown in figure 29.

Table 202 - Practices Required for Cooperative Conservation Development, Subregion 4

Target Date and State	Water-sheds (No.)	Flood Protection	Erosion Control	Drainage	Irrigation New	Irrigation Supplemental	Land Treatment
		(1,000 acres)					
1980							
Idaho	(18)	151.7	529.4	89.3	150.5	46.3	982.6
Nevada	(1)	-	-	-	-	-	-
Utah	(0)	-	-	-	-	-	-
Wyoming	(6)	7.4	5.9	4.4	5.2	25.1	50.8
Total	25	159.1	535.3	93.7	155.7	71.4	1,033.4
No. Watersheds	(25)	(20)	(23)	(21)	(20)	(16)	(23)
2000							
Idaho	(26)	104.4	602.6	132.0	171.4	119.9	980.7
Nevada	(0)	-	-	-	-	-	-
Utah	(0)	-	-	-	-	-	-
Wyoming	(7)	5.0	2.6	18.7	11.5	49.8	74.4
Total	33	109.4	605.2	150.7	182.9	169.7	1,055.1
No. Watersheds	(33)	(28)	(29)	(25)	(27)	(22)	(31)
2020							
Idaho	(32)	92.8	433.2	59.1	437.0	127.7	1,070.1
Nevada	(2)	2.8	317.0	0.1	5.0	2.5	4.0
Utah	(1)	-	10.0	-	2.0	1.0	2.6
Wyoming	(6)	1.5	2.2	6.2	0.6	5.9	15.8
Total	41	97.1	762.4	65.4	444.6	137.1	1,092.5
No. Watersheds	(41)	(24)	(36)	(19)	(33)	(23)	(38)

Source: Soil Conservation Service, C-NPRBS Data.

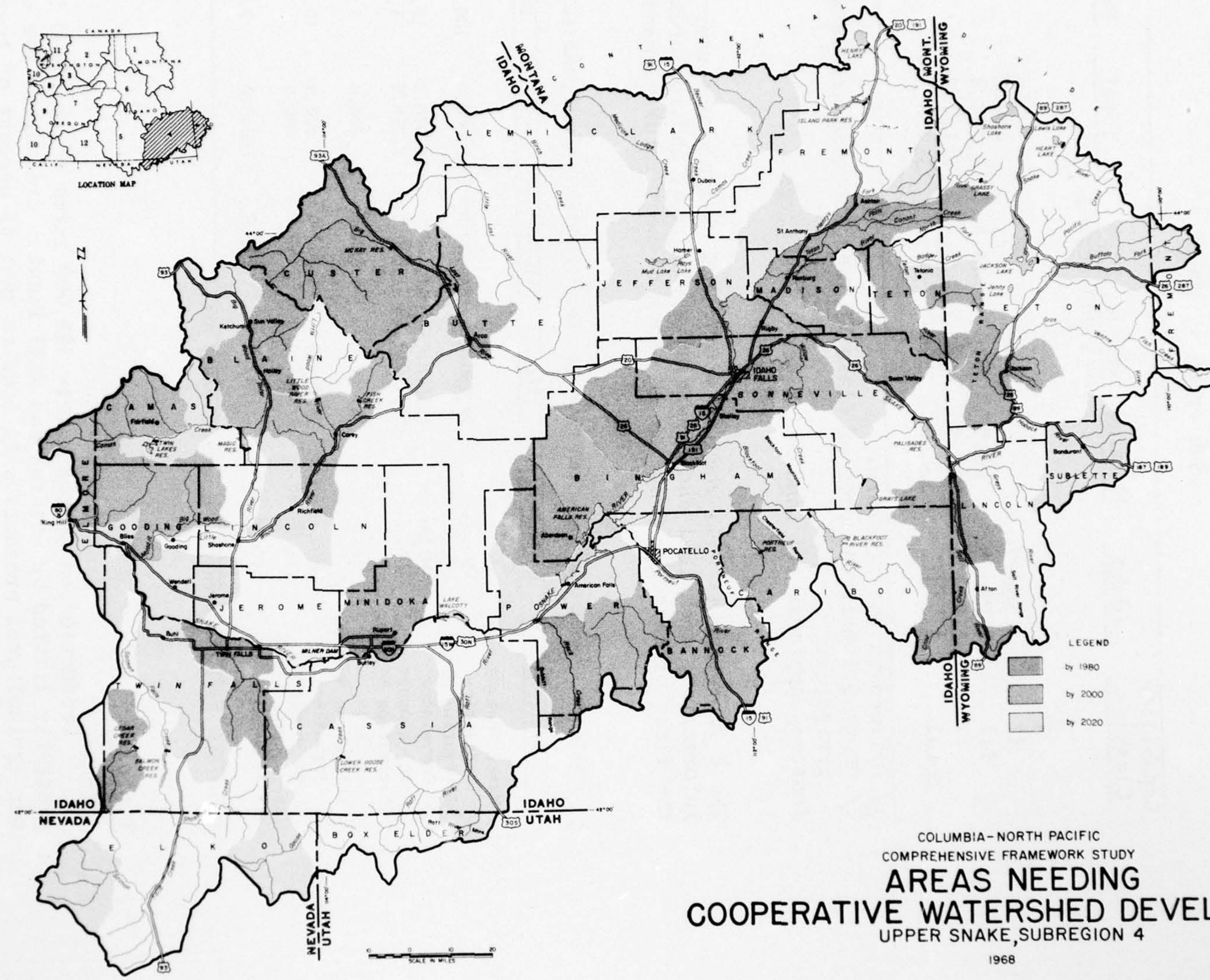
Cropland

Total cropland is projected to increase some 79,000 acres by 2020. However, irrigated cropland is projected to increase about 709,000 acres from 2.4 million acres in 1966 to 3.1 million acres in 2020. This subregion leads all others in acres cultivated in 1966, and it will continue to lead the region by 2020 according to cropland projections. The rate at which the cropland area needs to receive irrigation water, be drained, and protected from flooding and erosion damage is presented in this section. A variety of construction and land treatment practices must be applied to the land in order to meet these needs. The land area capable of producing crops is shown in table 203 by capability class.

Water Conservation

Increase in the irrigated area and shifts in the method of applying water will require an increase in irrigation water management practices. Table 204 shows some of the practices needed to provide for the efficient use of irrigation water.

The need to improve water conservation will be met by improved equipment, management techniques, and irrigation skills.



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

AREAS NEEDING COOPERATIVE WATERSHED DEVELOPMENT

UPPER SNAKE, SUBREGION 4

1968

FIGURE 29

Table 203 - Land Area Suitable for Crop Production
Subregion 4, 1966

Capability Class1/	Idaho	Wyoming	Nevada	Utah	Total	Percent
			(1,000	acres)		
I	-	-	-	-	-	-
II	569.2	-	-	-	569.2	15
III	2,090.8	90.0	8.0	44.6	2,233.4	57
IV	1,084.2	40.0	-	-	1,124.2	28
Total	3,744.2	130.0	8.0	44.6	3,926.82/	100

1/ Defined in the glossary.
2/ About 3.1 million acres of Class VI land are also arable when irrigated.
Source: Appendix IV, Land and Mineral Resources.

These improvements will require strong and flexible programs of information, technical and financial assistance, and research along the lines of existing programs in order to meet future demands.

Table 204 - Cumulative Projected Practices for Irrigated Cropland, Subregion 4

Practice	Units	1966	1980	2000	2020
Water Control Facilities	No.	79,130.0	84,000.0	92,000.0	100,000.0
Irrigation Water Conveyance	Miles	12,320.0	13,000.0	14,000.0	15,000.0
Water Storage	No.	1,510.0	1,650.0	1,750.0	1,800.0
Irrigation System, Surface	No.	1,780.0	1,600.0	1,400.0	1,170.0
Irrigation System, Sprinkler	No.	2,200.0	4,800.0	7,800.0	10,800.0
Land Shaping	1,000 Ac.	461.0	560.0	740.0	920.0
Irrigation Water Management	1,000 Ac.	842.0	1,200.0	1,900.0	2,600.0

Source: Soil Conservation Service, C-NPRBS Data.

Drainage

Production on approximately 396,000 acres of cropland is presently limited by wetness and will require drainage. The demand for agricultural products will require that 43 percent of these soils be drained.

Some of the drainage problem is associated with irrigation and will improve as water is used more efficiently. Most of the

drainage problem will require construction of tile lines or open drains which benefit two or more farms. Drainage problem areas near Roberts, Blackfoot, Springfield, and Rupert need investigation. The solution to many of the drainage problems will be found through more detailed investigation and planning. Drainage practices necessary to drain the cropland areas at the projected rate are shown in table 205.

Table 205 - Cumulative Practices Required to Provide Needed Drainages, Subregion 4

Practice	Unit	1966	1980	2000	2020
Conduits & Ditches	Mi.	226	450	750	1,050
Structures	No.	27	150	250	330

Source: Soil Conservation Service, C-NPRBS Data.

Erosion and Sedimentation

Most cropland soils were transported to their present location by wind or water and are quite erodible. The loessal soils of the foothill dry farms are especially subject to wind and water erosion.

A large part of the dry cropland area has an erosion problem which is complicated by snow mold and footrot diseases of winter wheat. A program is needed to develop disease-resistant wheat strains, new tillage and seeding techniques, and improved tillage methods to control erosion and increase productivity. There will also need to be a means of disseminating the new knowledge to the land users and technical and monetary assistance to help them apply that knowledge.

The area to be treated will increase as the cropland acres increase and as land use shifts from grain and forage crops to a more intensified row crop type use. Erosion on dry cropland with moderate slopes can be generally controlled with management practices such as cropping sequence, cross slope operations, and crop residue use. Steeper land will require strip cropping and construction of diversions, grassed waterways and stream channel stabilization structures along with the management practices. Practices necessary to treat those areas with critical erosion problems and to maintain other areas in a stable condition are shown in table 206.

A tillage program of chiseling in the fall and sweep cultivation for weed control on fallow land provides good erosion protection and increased infiltration rate. Tilling across the slope further increases the infiltration and reduces erosion.

Table 206 - Cumulative Practices to Satisfy Erosion Control Needs, Subregion 4

Practices	Unit	1966	1980	2000	2020
Conservation Cropping System	1,000 Acs.	1,372	1,800	2,400	3,000
Crop Residue Use	1,000 Acs.	862	1,400	2,300	3,200
Ditch Bank Seeding	Mi.	331	600	900	1,200
Diversions & Terraces	Mi.	15	500	1,300	2,100
Field Wind Break	Mi.	305	1,000	2,500	4,000
Grade Stab. Structures	No.	187	400	700	1,000
Grassed Waterway	1,000 Acs.	3	5	6	7
Pasture & Hayland Planting	1,000 Acs.	137	300	500	700
Stripcropping	1,000 Acs.	14	50	100	150
Stubble Mulch	1,000 Acs.	233	400	450	500

Source: Soil Conservation Service, C-NPRBS Data.

On steep land the surface roughness alonc will not store the storm water and there must be some other means to handle the excess water. Stripcropping is necessary to provide an erosion resistant strip with an alternate unprotected strip. There may be some soil movement from one part of the field to another and there is some water loss, but little sediment moves off the field and water loss is not severe.

When there is more runoff than surface treatment and strip-cropping can control, diversions should be constructed across the slope to hold the surplus water. When properly spaced according to the slope of the land and the type of soil, water does not concentrate in erosive amounts. These diversions may carry the water off the field to a protected outlet or merely store the water for the short time required for infiltration. Waterways which receive appreciable amounts of runoff must be protected by vegetation or structures to prevent erosion.

Flooding

Approximately 283,000 acres of cropland are frequently flooded. These areas are used for pasture or hayland to minimize the economic damage by early spring flooding. In the climatic zones where high-value crops cannot be grown, the flooded land will continue to produce hay and pasture, and management techniques will be developed to maximize production without expensive flood control works. Flood channels and flood detention reservoirs will be constructed to prevent too frequent flooding of high-value cropland. In some places, such as the Twin Buttes area west of Blackfoot, the watershed will be treated to increase infiltration and reduce flood runoff. Multiple purpose reservoirs planned for

Teton River above Rexburg and for Willow Creek near Idaho Falls will greatly reduce flooding of large areas of high-value cropland and urban development.

Streambank erosion is a problem on some streams and will be treated by protecting the reaches which give particular difficulty. Projected stream channel and diking measures that are necessary to prevent local flooding are shown in table 207.

Table 207 - Cumulative Cropland Flood Prevention Practices, Subregion 4

Practices	Unit	1966	1980	2000	2020
Stream Channel Improvement	Mi.	70	150	250	350
Stream Channel Stabilization	Mi.	17	45	65	75
Stream Bank Protection	Mi.	20	50	110	180
Dikes and Levees	Mi.	51	70	110	150

Source: Soil Conservation Service, C-NPRBS Data.

Most of the required work will need to be done through local projects with public participation. Public funds will be used for cost sharing and technical assistance. Flood control works will be financed mostly by public funds.

The cost of protecting river banks from erosion cannot generally be economically justified from the standpoint of land protection; therefore, protection from downstream damages caused by debris, silt, and pollution must be included. For this reason, erosion control must be included in project planning when use of public funds is anticipated.

Program Costs

The cost of implementing conservation practices discussed in the previous sections are given in table 208 and are based on 1969 constant dollars.

Table 208 - Estimated Cost of Cropland Conservation Practices, Subregion 4

Item	Water Conservation	Drainage	Erosion Control	Flood Control	Total
			(1,000 dollars)		
1966-1980					
Private Funds	84,788	5,643	18,831	3,040	112,302
Public Funds	20,000	1,200	1,000	30,000	52,200
Technical Cost1/	3,430	176	3,100	6,100	12,806
Total	108,218	7,019	22,931	39,140	177,308
1981-2000					
Private Funds	182,200	10,650	36,100	5,000	233,950
Public Funds	50,000	3,000	2,000	42,435	97,435
Technical Cost1/	8,860	331	6,940	8,150	24,281
Total	241,060	13,981	45,040	55,585	355,666
2001-2020					
Private Funds	248,700	14,160	49,220	5,000	317,080
Public Funds	40,000	4,000	2,500	49,100	95,600
Technical Cost1/	11,800	440	9,250	8,640	30,130
Total	300,500	18,600	60,970	62,740	442,810

1/ Includes public and private costs.
Source: Soil Conservation Service, C-NPRBS Data.

Forest Land

Demands for wood products along with competition for non-consumptive forest land uses will cause mounting pressures on the forests of the subregion. These pressures will require accelerating levels of watershed protection, maintenance or reduction in present sediment levels, decreased flood flows, and increased streamflow yields through cover management. These practices must be a part of the structural and nonstructural programs designed to develop and protect the water resources of the area.

Watershed Protection

Present watershed protection practices applied in connection with logging and road construction, as outlined in table 188, are expected to improve on the public forest lands. A level at least equal to that presently used on public lands, will be necessary for the private areas. Table 209 outlines the anticipated total cost of such measures, accumulated through the year 2020. These costs are based on the assumption that: (1) On the public forest lands, controls through timber sale and construction contracts are adequate if properly applied, and (2) on the private forest lands, the minimum level required will be about equal that presently done on the public lands.

Table 209 - Projected Costs for Watershed Protection Practices, Forest Land, Subregion 4

Practices	Unit	Total Units1/	Total Cost1/ ($1,000)
PUBLIC FOREST LAND			
Logging Disturbance Treatment	Ac.	173,800	3,480
Harvest Road Treatment2/	Mi.	5,800	1,450
Other Watershed Requirements3/	Ac.	3,959,000	55,390
Total Cost			60,320
PRIVATE FOREST LAND			
Logging Disturbance Treatment	Ac.	24,000	360
Harvest Road Treatment	Mi.	800	160
Other Watershed Requirements	Ac.	197,000	8,360
Total Cost			8,880
TOTAL ALL LAND			
Logging Disturbance Treatment	Ac.	197,800	3,840
Harvest Road Treatment	Mi.	6,600	1,610
Other Watershed Requirements	Ac.	4,156,000	63,750
Total Cost			69,200

1/ *Total for 55-year period--1965-2020.* Costs in 1969 dollars.
2/ Includes road maintenance.
3/ Includes watershed surveys, plans, fire protection, timber cultural practices, special road requirements, and other indirectly related items.

At this rate, recurrent watershed protection measures will cost about $1,100,000 annually on the public forest lands and should cost $160,000 annually on the private. Converting the annual costs to totals, this amounts to $69,200,000 to maintain the productive condition of the forest watersheds with the increased demands through the year 2020.

Watershed Rehabilitation

The forest areas most in need of rehabilitation and the areas that rehabilitation dollars would do the most for in terms of sediment reduction and water quality improvement, are the areas in the low-condition category as listed in table 187, and those localized areas such as that pictured in the "Present Status"

section. These areas presently contribute nearly 160 acre-feet per year or 61 percent of the total sediment load from the forest lands in the subregion. The localized areas, particularly, should be given prompt attention to prevent development of major problems.

The forest land acreage presently requiring treatment and the amount that should be accomplished during time periods 1980, 2000, and 2020, is listed in table 210. Table 211 outlines the expected sediment reduction through the application of these measures.

Table 210 - Projected Watershed Rehabilitation Program, Forest Land, Subregion 4

Program	Unit	1980 Amount	1980 Cost1/ ($1,000)	2000 Amount	2000 Cost1/ ($1,000)	2020 Amount	2020 Cost1/ ($1,000)
FEDERAL LANDS							
Land Treatment	Ac.	28,000	2,771	43,000	4,421	44,500	4,483
Stream Rehabilitation	Mi.	15,000	77,700	20,000	103,600	27,805	144,061
Road Rehabilitation	Mi.	750	386	1,145	606	805	414
Total Cost			80,857		108,627		148,958
NONFEDERAL LANDS							
Land Treatment	Ac.	20,000	300	31,000	465	36,000	540
Stream Rehabilitation	Mi.	125	63	100	50	125	63
Road Rehabilitation	Mi.	20	1	45	1	55	1
Total Cost			364		516		604
TOTAL ALL LANDS							
Land Treatment	Ac.	48,000	3,071	74,000	4,886	80,500	5,023
Stream Rehabilitation	Mi.	15,125	77,763	20,100	103,650	27,930	144,124
Road Rehabilitation	Mi.	770	387	1,190	607	860	415
Total Cost			81,221		109,143		149,562

1/ In 1969 dollars.

The overall expected sediment reduction is 49 percent or nearly 130 acre-feet per year, principally from treatment on areas having past logging and grazing damage (table 211).

In addition to the needs for sediment reduction on the presently eroding forest lands, nonrecurrent work will be required both on future extensive forest burns and on lands directly related to future water storage projects. These sediment sources will be treated as needed. Hence, the 49 percent overall sediment reduction is that amount possible should no new sources occur through catastrophic fire or other natural disaster.

Table 211 - Expected Annual Sediment Reduction
Forest Land Rehabilitation, Subregion 4

Present 1/ Sediment Yield	Acres (1,000)	Total Sed. Yield Ac-ft./Yr.	Acres Treated 2/	Sediment Reduction Ac-ft/Yr.
Very low	3,276.8	102	--	--
Low	1,020.1	160	1,020,000	127.5
Medium	--	--	--	--
High	--	--	--	--
Very high	--	--	--	--
Total	4,296.9	262	1,020,000	127.5
		Total reduction, percent		49

1/ Data from table 189.
2/ Data from table 209. Miles treated converted to acres.

Water Yield Improvement

The projected water yield improvement programs needed and the amount that should be accomplished during time periods 1980, 2000, and 2020, are listed in table 212. No estimates were made for the private lands.

Table 212 - Projected Water Yield Improvement Practices, Public Forest Land, Subregion 4

Program	Unit	1980 Amount	1980 Cost1/ ($1,000)	2000 Amount	2000 Cost1/ ($1,000)	2020 Amount	2020 Cost1/ ($1,000)
Cover Manipulation2/	Ac.	11,500	182	13,000	243	12,600	227
Snowpack Management	Mi.	40	2,000	20	1,000	-	-
Water Spreading3/	Ac.	1,000	42	1,500	63	700	30
Total Cost			2,224		1,306		257

1/ In 1969 dollars.
2/ Includes type conversion and riparian vegetation management.
3/ Planned for altering timing of runoff or ground-water recharge, not for irrigation or other resource activity.

Total Program Costs

The total estimated costs of forest watershed protection and land treatment programs through the year 2020 are summarized below:

	Costs ($1,000)
Watershed Protection	69,200
Watershed Rehabilitation	339,926
Water Yield Improvement	3,787
	412,913

Rangeland

Measures and Practices for Watershed Protection

Measures required for future rangeland watershed protection, rehabilitation, and improvement are listed in tables 213, 214, and 215. Most of these practices which help to improve drainage,

Table 213 - Required Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, 1966 to 1980, Subregion 4

Measures & Practices	Units	Land Ownership Public 2/	Land Ownership Private	Land Ownership Total	Watershed Purposes 1/ (1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	874,600	172,300	1,046,900	-	x	x	x
Brush Control	Acres	983,100	193,700	1,176,800	-	x	x	-
Weed Control	Acres	277,200	54,600	331,800	-	x	x	-
Fertilizing	Acres	65,700	12,900	78,600	-	x	x	-
Conversion of Tree Cover to Grass	Acres	21,300	4,200	25,500	-	x	x	-
Contouring, Pitting, Furrowing	Acres	47,500	9,400	56,900	-	x	x	-
Deep Tillage	Acres	6,000	1,200	7,200	-	x	x	-
Stream & Bank Stabilization	Acres	13,000	2,600	15,600	-	x	x	x
Waterspreading	Acres	1,400	300	1,700	-	x	x	x
Irrigation	Acres	240	50	290				x
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	4,400	900	5,300	-	x	x	x
Reducing Excessive Grazing Use	Acres	2,099,800	413,700	2,513,500	-	x	x	x
Livestock & Game Water Facilities	Number	1,400	300	1,700	-	x	x	-
Special Fire Control	Acres	1,343,000	264,600	1,607,600	x	x	x	x
Roads, Cut & Fill Stabilization								
Existing Roads	Miles	2,000	400	2,400	-	x	x	-
New Roads	Miles	400	80	480	-	x	x	-
Abandoned Roads	Miles	30	6	36	-	x	x	-
Stream Clearance	Miles	75	15	90	x	x	x	x
Pollution Abatement	Miles	100	20	120	x	x	x	x
Water Control Structures								
Ponds & Small Reservoirs	Number	1,200	200	1,400	-	x	x	-
	Acre Ft.	12,800	2,500	15,300	-	x	x	-
Detentions	Number	300	60	360	-	x	x	-
	Cu. Yds.	164,600	32,400	197,000	-	x	x	-
Check Dams (Gully Plugs)	Number	8,900	1,700	10,600	-	x	x	x
	Cu. Yds.	127,200	25,000	152,200	-	x	x	x
Dikes	Lin. Ft.	10,700	2,100	12,800	x	x	x	x
Diversions	Number	33	6	39	x	x	x	x
	Cu. Yds.	38,000	7,500	45,500	x	x	x	x

1/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4-Flood & Debris Control.
2/ Includes Federal, State, County, and Municipal Ownership.
Source: Data collected from land management agencies specifically for the C-NP Study.

Table 214 - Required Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, 1981 to 2000, Subregion 4

Measures & Practices	Units	Land Ownership			Watershed Purposes[1]			
		Public[2]	Private	Total	(1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	631,500	124,400	755,900	-	x	x	x
Brush Control	Acres	669,500	131,900	801,400	-	x	x	-
Weed Control	Acres	402,600	79,300	481,900	-	x	x	x
Fertilizing	Acres	101,500	20,000	121,500	-	x	x	-
Conversion of tree cover to grass	Acres	2,200	400	2,600	-	x	x	x
Contouring, Pitting, Furrowing	Acres	19,100	3,800	22,900	-	x	x	-
Deep Tillage	Acres	6,000	1,200	7,200	-	x	x	-
Stream & Bank Stabilization	Acres	13,300	2,600	15,900	-	x	x	x
Waterspreading	Acres	2,400	500	2,900	-	x	x	x
Irrigation	Acres	50	10	60	-	x	x	x
Water Oriented Land Management Practices								
Livestock Control Fences	Miles	3,100	600	3,700	-	x	x	x
Reducing Excessive Grazing Use	Acres	64,200	12,600	76,800	-	x	x	x
Livestock & Game Water Facilities	Number	2,000	400	2,400	-	x	x	-
Special Fire Control	Acres	1,945,500	383,300	2,328,800	x	x	x	x
Roads, Cut & Fill Stabilization								
Existing Roads	Miles	2,300	500	2,800	-	x	x	x
New Roads	Miles	500	100	600	-	x	x	x
Abandoned Roads	Miles	150	30	180	-	x	x	x
Stream Clearance	Miles	75	15	90	x	x	x	x
Pollution Abatement	Miles	100	20	120	x	x	x	x
Water Control Structures								
Ponds & Small Reservoirs	Number	1,100	200	1,300	-	x	x	-
	Acre Ft.	24,700	4,900	29,600	-	x	x	-
Detentions	Number	350	70	420	-	x	x	-
	Cu. Yds.	213,500	42,100	255,600	-	x	x	-
Check Dams (Gully Plugs)	Number	13,600	2,700	16,300	-	x	x	x
	Cu. Yds.	99,700	19,600	119,300	-	x	x	x
Dikes	Lin. Ft.	17,900	3,500	21,400	x	x	x	x
Diversions	Number	30	6	36	x	x	x	x
	Cu. Yds.	33,300	6,600	39,900	x	x	x	x

1/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage: Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4-Flood & Debris Control.
2/ Includes Federal, State, County, and Municipal Ownership.
Source: Data collected from land management agencies specifically for the C-NP Study.

increase water yields, provide erosion and water quality control, and decrease flood and debris damage also have other management objectives or purposes.

Cover improvement and soil stabilization practices are required on about 6.6 million acres of rangeland between 1966 and 2020. Many of them will be recurring and a combination of practices will be applied on some of the same range areas. Nearly 2.2 million acres will need revegetation, primarily grass seeding (including reseeding of 623,600 acres), and brush should be controlled on 2.5 million acres. Around 70 percent of the revegetation efforts and 55 percent of the brush control work will be for watershed improvement. Other significant cover and stabilization measures include fertilizing 345,300 acres; contouring or furrowing 98,700 acres; deep tillage on 21,600 acres; removal of scattered trees to establish grass cover on 30,700 acres; and about 2,000 miles of bank stabilization along streams or above reservoirs.

Soil surveys now cover an estimated 5.0 million acres of rangeland and an additional 6.6 million acres should be mapped by 2020. More intensive secondary surveys will be required on approximately 7.6 million acres. Watershed management plans which now embrace nearly 2.0 million acres of rangeland should be extended to some 10.6 million acres by 2020.

Table 215 - Required Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, 2001 to 2020, Subregion 4

Measures & Practices	Units	Land Ownership			Watershed Purposes[1]			
		Public[2]	Private	Total	(1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	330,700	65,100	395,800	-	x	x	x
Brush Control	Acres	467,200	92,000	559,200	-	x	x	x
Weed Control	Acres	225,900	44,500	270,400	-	x	x	x
Fertilizing	Acres	121,300	23,900	145,200	-	x	x	-
Conversion of tree cover to grass	Acres	2,200	400	2,600	-	x	x	x
Contouring, Pitting, Furrowing	Acres	15,800	3,100	18,900	-	x	x	-
Deep Tillage	Acres	6,000	1,200	7,200	-	x	x	-
Stream & Bank Stabilization	Acres	13,600	2,700	16,300	-	x	x	x
Waterspreading	Acres	3,000	600	3,600	-	x	x	x
Irrigation	Acres	50	10	60	-	x	x	x
Water Oriented Land Management Practices								
Livestock Control Fences	Miles	3,300	600	3,900	-	x	x	x
Reducing Excessive Grazing Use	Acres	11,900	2,400	14,300	-	x	x	x
Livestock & Game Water Facilities	Number	1,800	400	2,200	-	x	x	-
Special Fire Control	Acres	2,540,600	500,500	3,041,100	-	x	x	x
Roads, Cut & Fill Stabilization								
Existing Roads	Miles	2,300	400	2,700	-	x	x	x
New Roads	Miles	400	100	500	-	x	x	x
Abandoned Roads	Miles	400	100	500	-	x	x	x
Stream Clearance	Miles	70	15	85	x	x	x	x
Pollution Abatement	Miles	75	15	90	x	x	x	x
Water Control Structures								
Ponds & Small Reservoirs	Number	1,100	200	1,300	-	x	x	-
	Acre Ft.	600	100	700	-	x	x	-
Detentions	Number	250	50	300	-	x	x	-
	Cu. Yds.	244,600	48,200	292,800	-	x	x	-
Check Dams (Gully Plugs)	Number	11,700	2,300	14,000	-	x	x	x
	Cu. Yds.	87,200	17,200	104,400	-	x	x	x
Dikes	Lin. Ft.	21,500	4,200	25,700	x	x	x	x
Diversions	Number	30	6	36	x	x	x	x
	Cu. Yds.	33,300	6,600	39,900	x	x	x	x

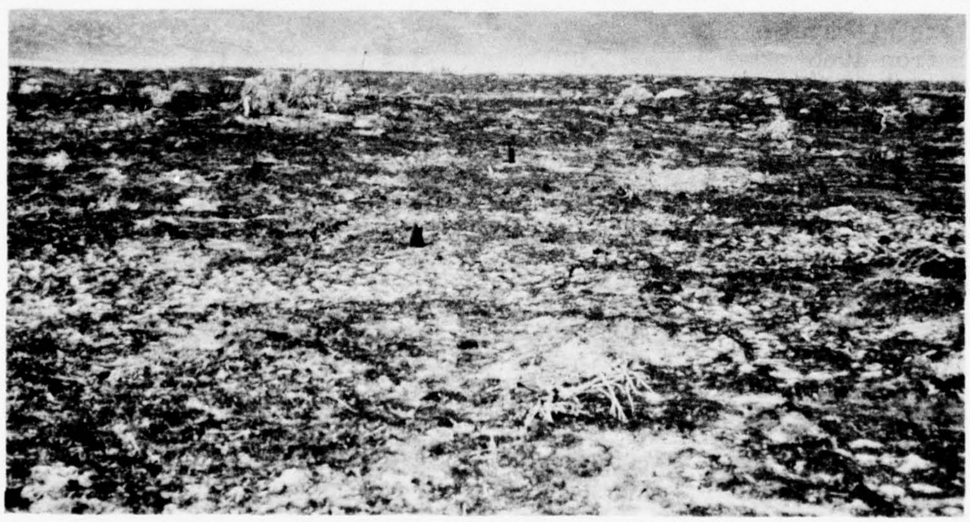
1/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4-Flood & Debris Control.
2/ Includes Federal, State, County, and Municipal Ownership.
Source: Data collected from land management agencies specifically for the C-NP Study.

Improved grazing management practices have allowed reduction or adjustment of livestock use on about 10.9 million acres through 1965. By 2020, an additional 2.6 million acres will require attention along with increased development of grazing management systems that will increase range carrying capacity while assuring adequate cover improvement and soil stabilization for watershed protection. Construction of 12,900 miles of livestock fence and development of 6,300 livestock and game water facilities are needed in these improved management programs.

Control of range fires is essential to protection of the forage crop and watershed cover and special fire prevention efforts will be required on about 7.0 million acres, including extra fire patrol, fire breaks, and the development of facilities for fire control water supply. On about 7,900 miles of existing range roads and trails, considerable work is required to reduce excessive runoff and erosion. Similar attention is needed on an estimated 1,600 miles of new roads and approximately 700 miles of abandoned roads. Some 270 miles of streams and waterways need stream clearance, and pollution abatement measures are required along about 330 miles of streams.

Channel cutting in Timber Gulch near Shoshone. Stabilization is necessary to reduce soil loss. (Bureau of Land Management)

Required water control structures between 1966 and 2020 include about 4,700 ponds and small reservoirs with a total storage capacity of some 2,800 acre-feet, 1,100 detention or diversion dams, 40,900 small check dams, and about 11 miles of dikes.



Range fires, such as the Magic Fire in Twin Fall County, Idaho, destroy vegetative cover on thousands of acres annually, leaving soils unprotected and subject to wind and water erosion. (Bureau of Land Management)

Erosion and Sediment Yield Improvement

Because of the precipitation pattern and highly permeable soils, the highest sediment yield areas in this subregion are in the "Low" and "Medium" classes shown on table 191. These areas represent about 32 percent of the total range acreage but contribute about 1,056 acre-feet annually or 55 percent of the total sediment load. Practices shown on tables 213, 214, and 215 for erosion and water quality control should be concentrated on these areas. Reduction or redistribution of grazing use on some areas and improved vegetative cover should result in a reduction of approximately 34 percent of the annual sediment yield. This reduction is shown on table 216 from 1,917 acre-feet annually in 1966 to 1,265 acre-feet in 2020.

Table 216 - Annual Sediment Yield Projections from Rangeland, Subregion 4

Sediment Yield Categories1/	1966	1980	2000	2020
		Rangeland Acreage (1,000 acres)		
Very Low	9,181.5	10,023.4	11,635.4	13,251.7
Low	4,274.5	3,262.9	1,681.8	98.3
Medium	99.8	75.7	37.8	-
High	-	-	-	-
Very High	-	-	-	-
Total	13,555.8	13,362.0	13,355.0	13,350.0
Percent change from 1966	.0	-1.4	-1.5	-1.5
		Annual Sediment Yield (acre-feet)		
Very Low	861	940	1,091	1,242
Low	1,002	765	394	23
Medium	54	41	21	-
High	-	-	-	-
Very High	-	-	-	-
Total	1,917	1,746	1,506	1,265
Percent change from 1966	0	-9	-21	-34

1/ Very Low through Very High categories represent generalized range areas on which annual sediment yield per square mile averages .06, .15, .35, 1.00, and 2.75 acre-feet, respectively.

Improved Range Condition and Capacity

Estimated future range improvement, shown on table 217, will result in part from accomplishment of required measures and practices for watershed protection, shown in tables 213, 214, and 215, and in part from management practices for improved forage production. In 1966 only 19 percent of the rangeland was in good range condition. With scheduled improvements, good condition range will be increased to 78 percent by 2020, from 2.5 million acres in 1966 to 10.4 million acres in 2020. About 2.5 million acres were in poor range condition in 1966, accounting for 18 percent of all rangeland. This will be decreased to 634,000 acres or 5 percent by 2020. Rehabilitation efforts will be directed to poor condition rangeland.

Table 217 - Estimated Potential Rangeland Improvement, Subregion 4

Range Type and Condition	1966 Acres (1,000)	1966 AUMs (1,000)	1980 Acres (1,000)	1980 AUMs (1,000)	2000 Acres (1,000)	2000 AUMs (1,000)	2020 Acres (1,000)	2020 AUMs (1,000)
Grassland								
Good	286.0	77.3	537.1	145.2	947.8	256.1	1,262.2	341.1
Fair	1,294.4	199.1	1,027.8	158.1	629.8	96.9	333.0	51.2
Poor	143.8	10.3	134.7	9.6	121.1	8.7	102.9	7.4
Seeded Range	1,152.2	384.1	1,789.9	596.6	2,375.1	791.7	2,680.2	893.4
Total	2,876.4	670.8	3,489.5	909.5	4,073.8	1,153.4	4,378.3	1,293.1
Sagebrush								
Good	1,019.3	169.9	2,411.3	401.9	4,675.5	779.2	6,405.1	1,067.5
Fair	7,135.0	849.4	5,666.6	674.6	3,463.9	412.4	1,797.5	214.0
Poor	2,038.6	128.2	1,315.1	82.7	662.5	41.7	290.0	18.2
Total	10,192.9	1,147.5	9,393.0	1,159.2	8,801.9	1,233.3	8,492.6	1,299.7
Other Brush								
Good	48.7	8.1	55.2	9.2	69.4	11.5	97.8	16.3
Fair	145.9	18.2	142.4	17.8	142.2	17.8	140.4	17.6
Poor	291.9	17.4	281.9	16.8	267.7	15.9	240.9	14.3
Total	486.5	43.7	479.5	43.8	479.3	45.2	479.1	48.2
Total								
Good[1/]	2,506.2	639.4	4,793.5	1,152.9	8,067.8	1,838.5	10,445.3	2,318.3
Fair	8,575.3	1,066.7	6,836.8	850.5	4,235.9	527.1	2,270.9	282.8
Poor	2,474.3	155.9	1,731.7	109.1	1,051.3	66.3	633.8	39.9
Grand Total	13,555.8	1,862.0	13,362.0	2,112.5	13,355.0	2,431.9	13,350.0	2,641.0
Average AC/AUM	7.3		6.3		5.5		5.1	
Percent change from 1966	.0	.0	-1.4	+13.5	-1.5	+30.6	-1.5	+41.8

1/ Includes seeded range.
Source: Table 217 "Present Status" rangeland narrative. Future estimates for this study are based on representative on-site surveys for production guides with consideration to the capability of the range for improvement with proper management and utilization.

This improved condition and a decline in total range acreage by 2020, will result in an expected 42 percent increase in grazing capacity from 1.9 million AUMs to 2.6 million AUMs. Even with this substantial improvement, range forage production will meet only about 6.4 percent of the anticipated demand for livestock production in Subregion 4 by 2020, compared to 12.7 percent in 1966.

Estimated Program Investment Costs

Investment cost estimates (based on 1969 dollars) are given in table 218 for all future measures and practices shown on tables 213, 214, and 215. Cover improvement and soil stabilization programs will require $73.2 million between 1966 and 2020, or 76 percent of the total $96.0 million rangeland watershed costs. Watershed oriented land management practices require $17.4 million or 18 percent of total program costs, and water control structures require $5.4 million or 6 percent of total costs.

Table 218 - Estimated Cost of Required Measures and Practices for Watershed Protection and Rehabilitation of Rangeland by Major Types of Watershed Programs, Subregion 4 1/

Major Types of Watershed Programs	1966 to 1980 ($1000)	1980 to 2000 ($1000)	2000 to 2020 ($1000)	Total ($1000)
		Public Land		
Cover Improvement and Soil Stabilization	21,940.5	21,146.3	18,021.6	61,108.4
Watershed Oriented Land Management Practices	4,724.0	4,783.8	5,010.7	14,518.5
Water Control Structures	1,552.5	1,489.9	1,500.5	4,542.9
Total	28,217.0	27,420.0	24,532.8	80,169.8
		Private Land		
Cover Improvement and Soil Stabilization	4,385.7	4,149.7	3,571.8	12,107.2
Watershed Oriented Land Management Practices	973.5	943.3	1,002.8	2,919.6
Water Control Structures	262.1	269.4	275.4	806.9
Total	5,621.3	5,362.4	4,850.0	15,833.7
		Total		
Cover Improvement and Soil Stabilization	26,326.2	25,296.0	21,593.4	73,215.6
Watershed Oriented Land Management Practices	5,697.5	5,727.1	6,013.5	17,438.1
Water Control Structures	1,814.6	1,759.3	1,775.9	5,349.8
Total	33,838.3	32,782.4	29,382.8	96,003.5

1/ Based on measures and practices shown on tables 213, 214, and 215, with constant 1969 dollars.

Based on the present ratio of rangeland ownership, an estimated $80.2 million will be needed for the public range (84 percent of total requirements), while the private range will require $15.8 million or 16 percent of all needs.

Other Land

The other land acreage is projected to increase approximately 79,000 acres by 2020 to meet needs of an expanding population and associated land use requirements. Some 29,000 acres of this increase will be for intensive urban, industrial, and other special uses.

Joint coordinated planning must be accomplished by all levels of government and private interests to meet watershed needs in these areas, in conjunction with needs of adjacent developing agricultural and rural areas.

Soil surveys and interpretative analyses will provide essential basic data to adequately plan new urban developments needed due to population increases. These soil surveys would provide planners information essential to effect future land use changes with adequate watershed protection and improvement. Results of these surveys should be reflected in urban and suburban zoning ordinances.

More intensive study is required to determine the full extent of water supply problems for municipal, industrial, and rural domestic uses and to develop feasible solutions for adequate sewage treatment, pollution abatement, and sources of water.

Erosion and sediment from adjoining lands and construction sites creates continuing and increasing problems in urban and industrial areas. Measures to control these problems include land treatment on adjacent land, more adequate floodways, debris basins, and strict construction controls to reduce damage.

Increased flood protection for the more intensive use areas will be improved by reservoir storage to reduce peak flows and at the same time provide water for recreation and municipal and industrial use. Enlarged and improved channels or dikes and levees will provide additional flood protection. Land treatment measures, which were listed previously, will help to prevent damages to roads, bridges, streets, residential, commercial, and industrial developments. Prevention of silt accumulation in reservoirs and channels will be an additional benefit. These measures, along with flood plain zoning, will reduce flood damage on the 8,200 acres now subject to frequent flooding and prevent this problem from growing.

In parts of the subregion, damage is caused by blowing sand and creation of dunes. An estimated 185,000 acres of dune stabilization work should be accomplished between 1966 and 2020. This includes planting or seeding of some areas and other measures, such as construction of fiberglass mats and wind fences, to prevent expansion of sand areas.

Most measures and practices required to satisfy needs for other land have been included and costed in other sections of this appendix and in Appendices VII, Flood Control; IX, Irrigation; XI, Municipal and Industrial Water Supply; and XII, Water Quality and Pollution Control.

REGION 5

LOCATION MAP

S U B R E G I O N 5
C E N T R A L S N A K E

PRESENT STATUS

Subregion 5, Central Snake, includes all of the Snake River drainage between King Hill and Hells Canyon. It is bound by the Salmon River Drainage on the north, the Great Basin on the south, and the Closed Basins of Oregon on the west. The area makes up 14 percent of the region with 23,567,900 acres. This includes a land area of 23,397,500 acres and 170,400 acres of large water bodies. The land area is nearly 74 percent publicly owned, mostly Federal. The remaining 26 percent is private. The major Federal lands (46 percent) are public rangelands managed by the Bureau of Land Management.

Average annual precipitation runs from less than 8 inches per year in the arid areas to over 60 inches in the higher mountains. The frost-free periods vary considerably with elevation, ranging from 160 days in the Boise and Snake River Valleys to about 60-80 days in the mountains. Freezing temperatures can occur at any time above the 6,000-foot elevation.

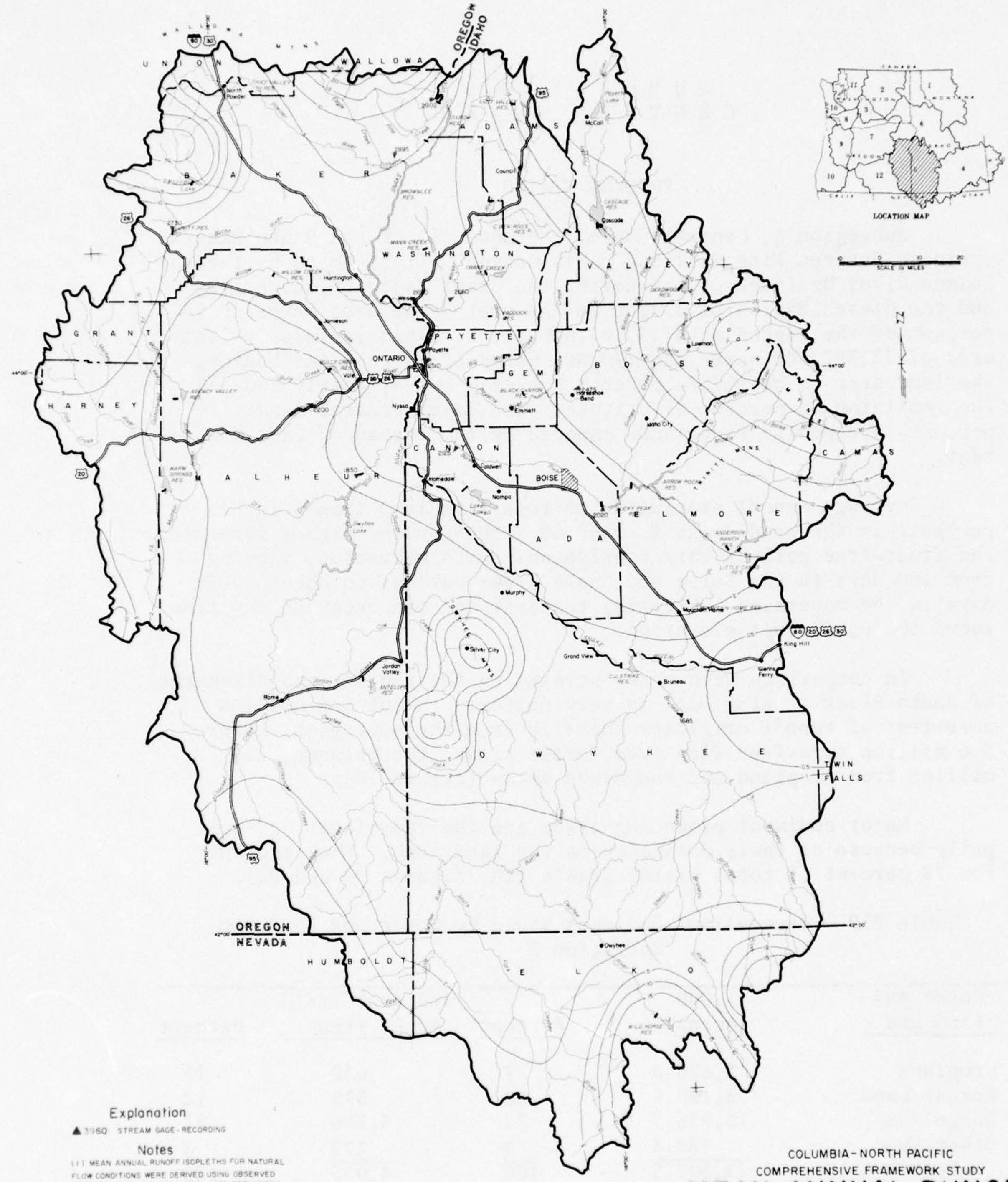
In comparison with other streams in the region, the discharge of Snake River at King Hill is very uniform. About 5-6 million acre-feet of runoff originate annually from the subregion. Over 3.6 million acre-feet flow from forest areas, the balance, 2.0 million from cropland and rangeland areas (figure 30).

Major sediment producing areas are the rangelands, principally because of their dominance on the landscape. They account for 72 percent of total yields (table 219, figures 30 and 32).

Table 219 - Generalized Sediment Yield by Cover and Land Use, Subregion 5

Cover and Land Use	1,000 Acres	Percent	Sediment Yield Ac.Ft./Year	Percent
Cropland	1,628.9	7	632	13
Forest Land	4,190.5	18	575	12
Rangeland	16,838.7	72	3,556	72
Other Land	739.4	3	172	3
Total	23,397.5	100	4,935	100

Source: Derived from figures 31 and 32 and Appendix IV.



Explanation

▲3960 STREAM GAGE - RECORDING

Notes

(1) MEAN ANNUAL RUNOFF ISOPLETHS FOR NATURAL FLOW CONDITIONS WERE DERIVED USING OBSERVED STREAM FLOWS, CLIMATOLOGICAL DATA, DEPLETIONS, AND PHYSIOGRAPHIC FEATURES OF THE BASIN FOR THE PERIOD 1931-1960.

(2) STREAM GAGING STATIONS SHOWN ARE SELECTED STATIONS AND ARE NOT THE ONLY STATIONS USED IN PREPARING THE RUNOFF MAP.

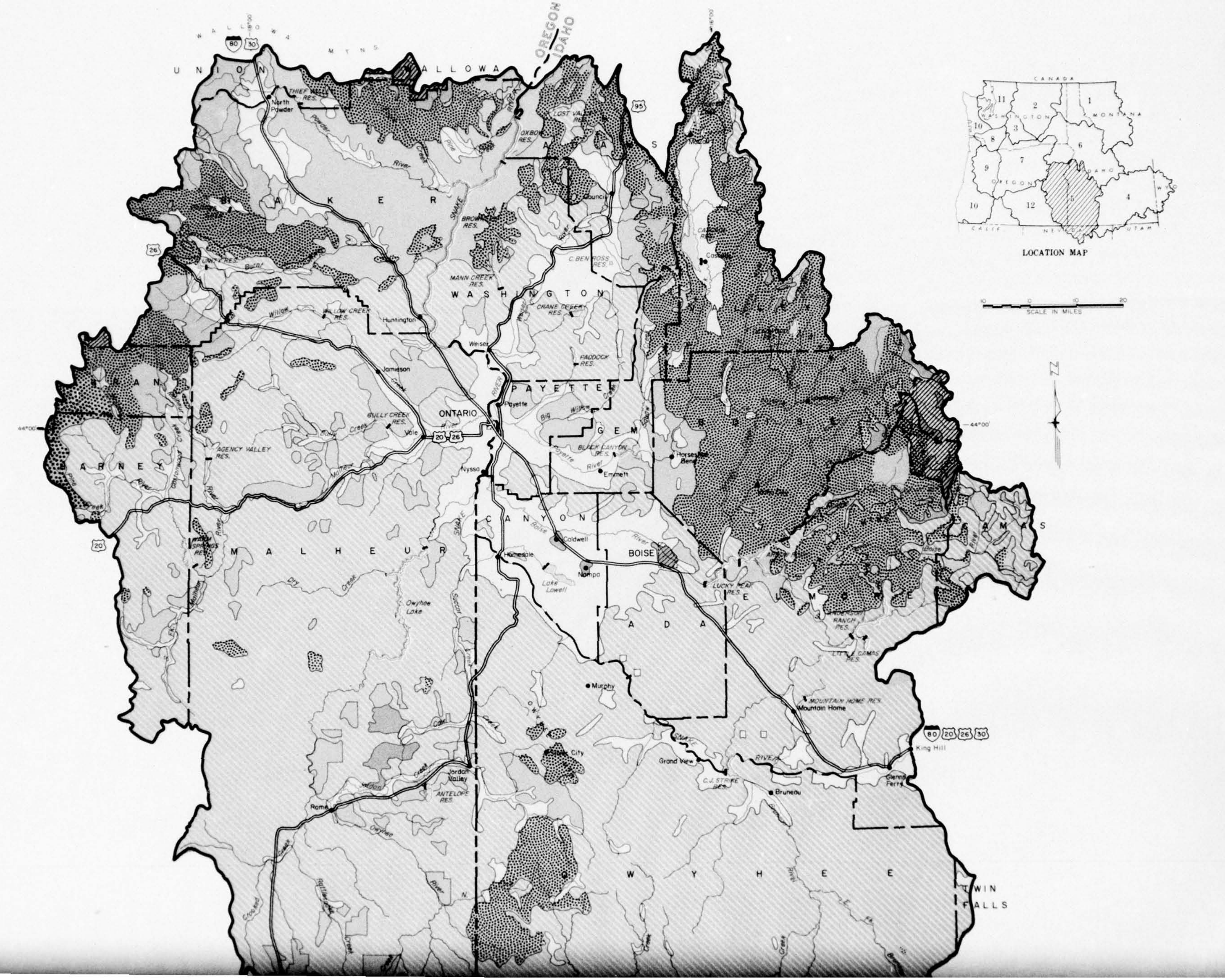
COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

MEAN ANNUAL RUNOFF IN INCHES

CENTRAL SNAKE SUBREGION 5

1968

FIGURE 30



LOCATION MAP
SCALE IN MILES
OREGON
IDAHO
WALLOWA MTNS
UNION
WALLOWA
BAKER
WASHINGTON
PAYETTE
GEM
CANYON
BOISE
ADA
ELMORE
CAMAS
MALHEUR
HARNEY
GRANT
OWYHEE
TWIN FALLS
ONTARIO
North Powder
Huntington
Jamieson
Vale
Nyssa
Weiser
Payette
Emmett
Caldwell
Nampa
Homedale
Murphy
Mountain Home
King Hill
Glenns Ferry
Grand View
Bruneau
Jordan Valley
Rome
Council
Cascade
Horseshoe Bend
THIEF VALLEY RES.
UNITY RES.
WILLOW CREEK RES.
BULLY CREEK RES.
AGENCY VALLEY RES.
BROWNLEE RES.
OXBOW RES.
MANN CREEK RES.
CRANE CREEK RES.
C. BEN ROSS RES.
PADDOCK RES.
BLACK CANYON RES.
LUCKY PEAK RES.
MOUNTAIN HOME RES.
LITTLE CAMAS RES.
C.J. STRIKE RES.
ANTELOPE RES.
Owyhee Lake
Lake Lowell
SNAKE RIVER
44°00'

COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

GENERALIZED COVER AND LAND USE

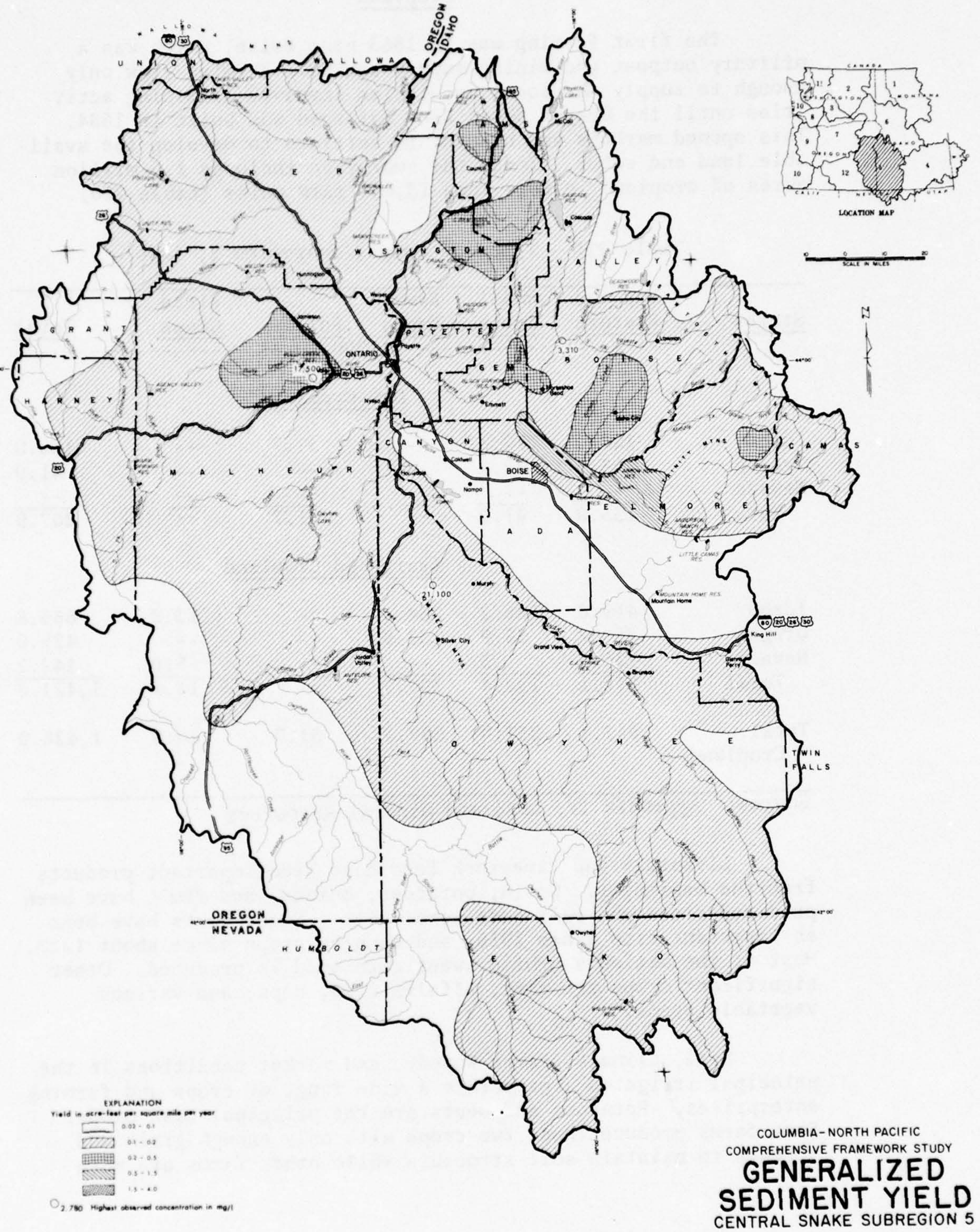
CENTRAL SNAKE, SUBREGION 5

1968

USDA SCS PORTLAND, OREG. 1970

FIGURE 31

2



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

GENERALIZED SEDIMENT YIELD

CENTRAL SNAKE SUBREGION 5

1968

FIGURE 32

Cropland

The first farming was in 1863 near Boise, which was a military outpost and mining supply center. Farming grew only enough to supply the local population involved in mining activities until the Oregon Short Line Railroad was built in 1884. This opened markets and brought in settlers to develop the available land and water. Today the subregion includes 1.6 million acres of cropland in more than 13,000 farm units (table 220).

Table 220 - Types of Crops, Subregion 5, 1966

States	Hay and Pasture	Small Grain	Row Crops	Fallow	Field Crops	Total
	1000 Acres					
			Dry Cropland			
Idaho	122.0	12.3	--	31.7	--	166.0
Oregon	13.0	28.9	--	--	--	41.9
Nevada	--	--	--	--	--	--
Total	135.0	41.2	--	31.7	--	207.9
			Irrigated Cropland			
Idaho	419.0	156.2	264.8	--	13.9	853.8
Oregon	256.2	35.9	132.9	--	--	425.0
Nevada	136.9	.3	--	--	5.0	142.2
Total	812.1	192.4	397.7	--	18.9	1,421.0
Total Cropland	947.1	233.6	397.7	31.7	18.9	1,628.9

Source: Appendix IV, Land and Mineral Resources

Livestock and livestock feed have been important products from the beginning. Grain, potatoes, onions, and fruit have been produced since the railroads were built. Sugar beets have been an important crop since 1936, and canning crops since about 1920. Most of the Nation's hybrid sweet corn seed is produced. Other significant crops are mint, alfalfa seed, hops, and various vegetable seeds.

Soil, climate, water supply, and market conditions in the principal irrigated area permit a wide range of crops and farming enterprises. Potatoes and beets are the principal cash crops. Some farms produce these two crops with only enough grain and legumes to maintain soil structure while other farms are more

diversified and include several other adapted crops. Many of the diversified farm enterprises include either dairy or beef cattle. Most sheep and beef operations use forest range and open rangeland, or mountain pastures during the summer and graze crop aftermath in the valleys during the winter. Table 220 shows the crops grown and the approximate acreage in each state.

Water Conservation

Because the cropland in this subregion is in an arid to semi-arid climate, water conservation is important to both irrigated and nonirrigated farming enterprises. Water conservation practices on irrigated cropland are land leveling, installation of pipelines, lined ditches, water control structures, improved irrigation systems, and water management. Tailwater is stored in ponds and reservoirs and pumped back for reuse. Table 221 shows the present status of water conservation practices applied to the cropland in the subregion.

Table 221 - Water Conservation Practices Applied on Cropland Through 1966, Subregion 5

Item	Unit	Idaho	Oregon	Nevada	Total
Water Control Facilities	No.	30,265	4,227	349	34,841
Irrigation Water Conveyance Facilities	Mi.	5,932	4,273	129	10,334
Water Storage Facilities	No.	59	119	4	182
Irrigation Systems, Surface	No.	1,621	184	50	1,855
Irrigation Systems, Sprinkler	No.	540	127	7	674
Irrigation Water Management	Ac.	169,190	65,198	3,540	237,928
Land Shaping	Ac.	273,288	83,257	6,140	362,685

Source: USDA, Soil Conservation Service Data

Approximately 1.4 million acres of land are irrigated. Table 222 shows the status of irrigation including acres irrigated, source of water, method of irrigation, and water-short areas.

Methods of irrigation vary from wild flooding to carefully designed border, dike, and sprinkler systems. The method used depends upon the soil texture and depth, the topography, the crop, the cost of water, and the opportunity to dispose of or reuse water. The intensity of irrigation water management varies from one agricultural area to another, as well as from farm to farm and depends on the crops grown, the cost and availability of water, and the labor supply.

Table 222 - Water Availability and Irrigation Methods for Cropland
Subregion 5, 1966

Item	Idaho	Oregon	Nevada	Total
			1000 Acres	
Water Source:				
Streamflow	221.1	237.5	122.9	581.5
Groundwater	60.0	5.9	--	65.9
Storage	572.7	181.6	19.3	773.6
Total	853.8	425.0	142.2	1,421.0
Area with Adequate Supply	625.9	253.2	142.2	1,021.3
Area with Inadequate Supply	227.9	171.8	--	399.7
Method of Irrigation:				
Flooding	751.1	412.5	142.2	1,305.8
Sprinkler	102.7	12.5	--	115.2

Source: Soil Conservation Service, C-NPRBS Data

The Snake River has adequate unregulated flow for land now irrigated from this source. The Boise, Payette, and Owyhee Rivers are regulated by storage to provide adequate supplies. Streams without storage, however, are not so reliable and several areas are short of water. The Snake River is fed by large springs just above the subregion boundary, but the rest of the surface water supply is from snowmelt, which is forecasted from snow survey data. Adequate ground water is generally available for land dependent upon this source.

Water conservation measures used on nonirrigated land include: (1) alternate wheat-fallow cropping, (2) stubble mulching, (3) chiseling, (4) contour farming, and (5) diversions. With the use of these practices the intercepted water infiltrates into the soil and is available for crops. The crop-fallow system, contour farming, stubble mulching, and chiseling are used on almost all nonirrigated cropland. Diversions are used to a limited degree in critical areas.

Drainage

In most of the subregion the slope of land, type of soil, and general topography provide for good natural drainage. Approximately 12 percent of the cropland, or 182,000 acres, has a

Inadequate surface and subsurface drainage causes ponding and crop damage at the lower end of irrigated fields. (SCS I-1824-12)

wetness problem which limits crop production. Seepage from canals and laterals, water lost through deep percolation, and poor irrigation water management have caused high water tables in many areas.

Drainage problems on about 13 percent of this area, or 24,000 acres, can be corrected by individual landowners. Complex drainage problems on the remaining 87 percent, or 158,000 acres, require project-type systems. Table 223 shows the present drainage problem areas by state and capability class. Saline wet areas require deep drainage and leaching. In areas having little or no salts, positive control of the water table is more important than indiscriminate drainage. Over irrigation on higher lands prolongs the wetness of lower lands unless drains are installed to control the water movement. Additional irrigation development will increase the need for drainage.

Table 223 - Cropland Areas with a Wetness Problem
Subregion 5, 1966

Capability Class	Idaho	Oregon	Nevada	Total
	1000 Acres			
II	38.0	17.0	26.5	81.5
III	36.0	20.0	35.3	91.3
IV	--	6.0	3.0	9.0
Total	74.0	43.0	64.8	181.8

Source: Soil Conservation Service, C-NPRBS Data

The level of management on wet land is low and most of it is in poor pasture. Drainage is expensive and more intensive land use will be required to make drainage feasible. Table 224 shows the present status of this work.

Table 224 - Drainage Practices Applied to Cropland
Subregion 5, 1966

Item	Unit	Idaho	Oregon	Nevada	Total
Drainage Ditches and Conduits	Mi.	351	270	7	628
Drainage Structures	No.	358	--	--	358

Source: Soil Conservation Service Data

Erosion and Sedimentation

Soil surveys indicate that erosion is a major problem on nearly 900,000 acres of cropland (table 225). More than 85 percent of the erodible cropland is irrigated. About 630 acre-feet of sediment comes from this land each year, as shown in figure 32 and table 219. It is 13 percent of the total sediment load from all lands in the subregion.

Table 225 - Cropland Areas with an Erosion Potential by Capability Class, Subregion 5, 1966

Capability Class	Idaho	Oregon	Nevada	Total
II	114	86	2	202
III	208	150	8	366
IV	125	130	40	295
Total	447	366	50	863

Source: Soil Conservation Service, C-NPRBS Data

Almost 65 percent of the dry cropland is relatively resistant to erosion because it is producing grass and legume hay and pasture. Most erosion on the dry cropland occurs in grain producing areas, predominantly in the Weiser and Powder River drainages. The standard practice under a grain-fallow system is to seed in the fall and to harvest the following summer. The stubble is left standing through the winter and is

plowed under in the spring. Rod weeders are used to control weeds in the summer fallow. Erosion is not a severe problem on stubble. However, in the areas seeded the preceding fall, erosion can be severe since the plants are small and the soil is loose. The average erosion rate from these areas is usually 5 to 10 tons per acre per year with much higher rates on individual fields.

Some of the work necessary to control erosion has been accomplished. Table 226 shows the present status of this work.

Table 226 - Erosion Control Practices Applied on Cropland, Subregion 5, 1966

Item	Unit	Idaho	Oregon	Nevada	Total
Conservation Cropping System	Ac.	417,203	86,912	4,350	508,465
Crop Residue Use	Ac.	300,107	11,003	250	311,360
Ditch Bank Seeding	Mi.	159	2	1	162
Diversions & Terraces	Mi.	11	2	1	14
Field Windbreaks	Mi.	8	1	0	9
Grade Stabilization Structures	No.	537	669	20	1,226
Grassed Waterways or Outlets	Ac.	124	123	340	587
Pasture and Hayland Planting	Ac.	60,448	4,831	3,660	69,939
Strip Cropping	Ac.	--	4,836	--	4,836
Stubble Mulching	Ac.	6,885	--	--	6,885

Source: USDA, Soil Conservation Service Data

On flatter slopes erosion is controlled by proper cropping and tillage practices. Crop rotations, which include grass and legumes in rotation with small grains, are used to maintain soil structure and to provide additional cover for the soil. Tillage practices, such as chiseling and stubble mulching, are used to protect the surface and increase water infiltration. Long or steep slopes usually require the use of structural measures such as terraces, diversions, and grassed waterways as well as proper cropping and tillage practices to control water movement on the land.

Erosion on irrigated land is the result of runoff from both precipitation and irrigation, with erosion from irrigation water being the more serious.

Surface irrigation on steep land erodes part of the field and deposits sediment on another part. (SCS I-45024)

Hay and pasture crops of grasses and legumes protect the soil from both water and wind erosion. Two exceptions are: (1) scouring caused by inundation of hay and pasture lands, and (2) erosion from wind and water for short periods during the reestablishment of the stand.

Wind erosion is serious in many newly irrigated areas. Land, located on benches or in areas of rolling topography, is usually worked in large fields and pulverized in seed bed preparation during the spring windy season. Windbreaks, cover crops, crop residue utilization, and rough tillage are often used to protect the soil in these areas.

Wind erosion near Parma, Idaho. Fine sandy soil blown from an unprotected field fills a road ditch and buries a fence. (SCS IDA-45366)

Flooding

About 79,000 acres of cropland are subject to flooding. Three types of weather conditions cause floods: (1) spring snowmelt in the mountains, (2) "Chinook" weather with rain on snow and frozen soil, and (3) intense rain from convective storms during the summer.

Runoff from snowmelt floods low areas along the Payette, Weiser, Bruneau, and Powder Rivers about once in 5 years and the Malheur once in 7 to 10 years. The Boise and Owyhee Rivers flood only once in 10 to 15 years because of the influence of storage. Since the large reservoirs in Subregion 4 were completed, the Snake River has not flooded in this subregion.

The Boise River has three large reservoirs that are operated for flood control and irrigation. Release and storage are based on water supply forecasts developed from snow survey data. Flooding is partially controlled by storage in three reservoirs on the Payette River. The Owyhee reservoir on the Owyhee River provides only incidental flood control because it is often filled with irrigation water when floods occur. Flood flows on the Malheur River are partially controlled by three reservoirs. Significant incidental flood regulation is accomplished on the Weiser and Powder Rivers by three reservoirs on each stream. The Bruneau River does not have flood control storage.

Farmyard and fields are eroded and covered with debris from a summer thunderstorm flood near Boise, Idaho. (SCS I-1273-5)

Dikes in several places along the main stems of the rivers protect cropland and urban areas. These dikes reduce the flood hazard but do not eliminate flooding because all of the rivers have heavy bed loads that tend to raise the riverbed. Willow thickets, gravel bars, and newly formed islands continually shift and restrict the flow.

Hay and pasture usually are grown on lands subject to frequent flooding and cause some damage from scour, deposition of silt, and delay in growth. Larger but less frequent floods inundate areas of high-income producing crops such as onions and sugar beets. These floods cause severe soil erosion and crop losses.

"Chinook" weather during the winter occurs quite frequently concurrently with a light (3" to 8") snow cover on frozen soil. This combination of rain, rapid snowmelt, and frozen soil causes heavy runoff from many areas which otherwise produce no water.

All agricultural land is subject to flooding from intense convective rain storms during the summer. These storms are localized, covering areas of less than 20 square miles, and generally last less than 1 hour. Total depth of precipitation is of a magnitude of 1 to 2 inches. Control of these floods can be accomplished by (1) maintaining adequate plant cover, and (2) providing detention storage. Total average annual flood damages are estimated in Appendix VII, Flood Control, to be over $3.7 million. Table 227 summarizes the conservation practices which have been applied for flood control.

Sediment from adjacent rangeland damages irrigated crops during summer floods. (SCS I-428-2)

Table 227 - Flood Control Measures Applied on Cropland Areas, Subregion 5, 1966

Item	Unit	Idaho	Oregon	Nevada	Total
Stream Channel Improvement	Miles	27	121	9	157
Dikes and Levees	Miles	46	Tr.	Tr.	46

Source: USDA Soil Conservation Service Data

Forest Land

Forests cover 4.2 million acres or 18 percent of the total land area in the subregion. About 87 percent is in public ownership and 13 percent is private. Of this, 67 percent is commercial forest land, 33 percent is noncommercial.

The commercial area supports nearly 34.5 billion board feet of merchantable timber, 95 percent on public land and 5 percent on private. This furnishes the raw material for one of the subregion's major industries. About 480 million board-feet were harvested in 1964. Both the commercial and noncommercial areas, including the million-acre pinon-juniper type, are also used extensively by big game and domestic livestock.

Although only 18 percent of the subregion is forested, over 65 percent of the streamflow originates here. Irrigation withdrawal, amounting to almost 6 million acre-feet annually, is the principal consumptive use.

The forest lands of the subregion are generally in a relatively good condition with very low overall sediment yields. Average annual sediment production is about 575 acre-feet, representing 12 percent of the total sediment coming from all lands in the subregion (table 228).

About 23 percent of the forest land is in the very low sediment yield category, principally from natural or geologic erosion. The remaining 77 percent is in more critical areas where land use activities have increased erosion. Some of these sites are located in depleted noncommercial forest grazing areas. The pinon-juniper type is one such area where overgrazing, by both livestock and wildlife, has destroyed the grass and sagebrush cover. This opens the area to erosion and allows invasion by junipers which do not provide a satisfactory cover for forage or for watershed protection purposes.

Overgrazed forest range on Juniper Mountain in the Owyhee Range. (Bureau of Land Management)

Table 228 - Present Sediment Yield Forest Land, Subregion 5

Sediment Yield Category	Acres (1,000)	Percent	Annual Sediment Yield: Acre-feet Per Square Mile	Annual Sediment Yield: Total Acre-Feet	Annual Sediment Yield: Percent
Very low	975.3	23	0.02 - 0.1	31	5
Low	2,946.5	70	0.1 - 0.2	460	80
Medium	268.7	7	0.2 - 0.5	84	15
High	--	--	0.5 - 1.5	--	--
Very high	--	--	1.5 - 4.0	--	--
Total	4,190.5	100		575	100

Source: Derived from figures 31 and 32

Watershed Protection

Timber harvesting practices include removal of the old, overmature stands in silviculturally selected blocks. This is done by mobile cable yarders, tractor-jammer operations, and highlead cable skidders.

Mobile cable yarder and loader operating on Payette National Forest. (Forest Service)

On most Federal and some non-Federal lands, tractor trails and temporary roads are cross-drained and seeded. Debris is removed from live streams and major draws preventing washouts which can cause damage to fish habitat, stream channels, and downstream improvements. Most permanent roads have permanent drainage structures installed at the time of construction. Heavily used timber haul roads often have gravel surfacing either in all or part for better wear and erosion control. In many cases, exposed cutbank and fill slopes are seeded to grasses to reduce soil movement. Road maintenance during and after log hauling is intended to protect the road and drainage structures as well as the soil and water resource.

Reforestation measures include both planting and seeding, usually preceded by site preparation. Advance reproduction is protected during the logging operation. These activities and protection measures are summarized in table 229.

Table 229 - Average Annual Timber Harvest Activity, Subregion 5

	Unit	Public	Private	Total
Harvest Area	Acres	23,000	8,000	31,000
Area Reforested 1/	Acres	2,000	500	2,500
Slash Disposal Area	Acres	20,000	1,500	21,500
Disturbed Area Treated 2/	Acres	3,500	--	3,500
Harvest Road Required	Miles	115	40	155
Harvest Road Treated 3/	Miles	95	--	95

1/ Includes planting, seeding, and site preparation. Balance either adequately stocked or requires no regeneration work.
2/ Includes seeding, mulching, debris removal and cross-draining skid roads and logging areas.
3/ Cut and fill stabilization only.

Watershed Rehabilitation

About 77 percent of the forest land has erosion problems that produce 95 percent of the present sediment load (table 228). Most of this sediment results from water movement through road ditches, down abandoned roads, through strip mining, and across areas logged over or overgrazed years ago. Public lands are now being rehabilitated as rapidly as funds permit. Current activities include streambank rehabilitation measures such as gabion construction, riprap, willow planting, revetments, and channel clearing and strip mine rehabilitation, trenching, backfilling, seeding, and planting. Abandoned roads are usually cross-drained, pitted, and/or seeded to reduce soil movement.

Such work on the public forest areas includes annual treatment on over 1,500 acres; nearly 330 miles of existing and abandoned roads and 70 miles of stream. This work, listed on table 230, is based on today's level of funding.

Those areas rehabilitated on a project basis following forest fires are not included in this table. Measures such as contour trenching, furrowing, aerial seeding, and planting of trees and shrubs are being used to stabilize soils on burned areas.

Table 230 - Average Annual Accomplishment, Watershed Rehabilitation Practices, Public Forest Land, Subregion 5

Practice	Unit	National Forest 1/	Public Domain	State Lands
Sheet Erosion Control	Ac.	1,800	700	--
Gully Stabilization	Mi.	125	--	--
Stream Clearance & Stabilization	Mi.	70	--	--
Existing Road & Trail Rehab. 2/	Mi.	330	5	--
Reservoir Protection	Ac.	50	--	--

1/ Average of period 1964-66.
2/ Includes abandoned roads.
Source: Data furnished by agency as listed.

Water Yield Improvement

Water yield accomplishment so far has been limited to experimental cutting programs and an evaluation of the results using mathematical models.

Rangeland

Rangeland in Subregion 5 amounts to 16.8 million acres, or 72 percent of the land area (table 219). Seventy-eight percent (13.1 million acres) is in public ownership and 3.7 million acres or 22 percent is private. Rangeland acreage and ownership is discussed in Appendix IV, Land and Mineral Resources. Table 231 shows current rangeland condition and grazing capacity. Sagebrush is predominant on 82 percent of the range, grass and forbs on 11 percent, and other brush or shrubs on 7 percent. Some of the better rangeland is in private ownership which has an estimated grazing capacity of 10 acres per animal unit month compared to 12 acres per animal unit month on the public range.

This subregion is one of the most important range livestock areas in the Columbia-North Pacific Region. In the early grazing use of the area, vast expanses of public range offered a source of inexpensive feed, and the land was stocked for the immediate returns without regard for the future of the land. This disregard for the inability of the lands to withstand improper use resulted in progressive deterioration of range and watershed resources. Damage was intensified by the competing wildlife use of many range areas. Nonpalatable brush and forbs increased while the perennial grass cover was depleted. Increased annual species of grasses and forbs are not as well suited for holding soil as the fibrous root system of perennial grasses. In the process, soil conditions conducive to

Table 231 - Rangeland Condition and Capacity, Subregion 5, 1966

Range Type and Condition	Ownership					
	Public		Private		Total	
	Acres (1,000)	AUM's (1,000)	Acres (1,000)	AUM's (1,000)	Acres (1,000)	AUM's (1,000)
Grassland						
Good	16.4	4.1	66.7	16.7	83.1	20.8
Fair	46.0	5.9	147.6	18.9	193.6	24.8
Poor	397.7	23.4	362.8	21.4	760.5	44.8
Seeded Range 1/	623.7	178.2	184.9	52.8	808.6	231.0
Total	1,083.8	211.6	762.0	109.8	1,845.8	321.4
Sagebrush						
Good	587.6	78.4	1,008.0	134.4	1,595.6	212.8
Fair	5,680.7	473.4	1,196.7	99.7	6,877.4	573.1
Poor	4,725.4	225.0	556.4	26.5	5,281.8	251.5
Total	10,993.7	776.8	2,761.1	260.6	13,754.8	1,037.4
Other Brush						
Good	115.0	11.5	72.9	7.3	187.9	18.8
Fair	429.2	28.2	79.2	5.2	508.4	33.4
Poor	477.0	19.8	64.8	2.7	541.8	22.5
Total	1,021.2	59.5	216.9	15.2	1,238.1	74.7
Total						
Good 2/	1,342.7	272.2	1,332.5	211.2	2,675.2	483.4
Fair	6,155.9	507.5	1,423.5	123.8	7,579.4	631.3
Poor	5,600.1	268.2	984.0	50.6	6,584.1	318.8
Grand Total	13,098.7	1,047.9	3,740.0	385.6	16,838.7	1,433.5
Percent Distribution	77.8	73.1	22.2	26.9	100.0	100.0
Average AC/AUM	12.5		9.7		11.7	

1/ Seeded range acreage was combined with good and fair condition grassland in Appendix IV.
2/ Includes seeded range.
Source: Rangeland narrative, C-NP Appendix IV, Subregion 5. Range production has been estimated for the C-NP Study from representative situations observed and recorded in on-site surveys. Estimates are based on perennial vegetation and proper utilization.

maximum yields of usable water have deteriorated, causing decreased infiltration rates and increased runoff. With growing awareness of these problems, gradual improvement has been made since the 1930's. By 1966, a number of practices had been established to improve forage production, maintain soils, and reduce downstream flood and sediment damage. Excessive grazing had been reduced on an estimated 33 percent of the range (about 5.5 million acres), but 39 percent of all rangeland was still in poor condition. Complete range recovery will require continued careful management and will take many years.

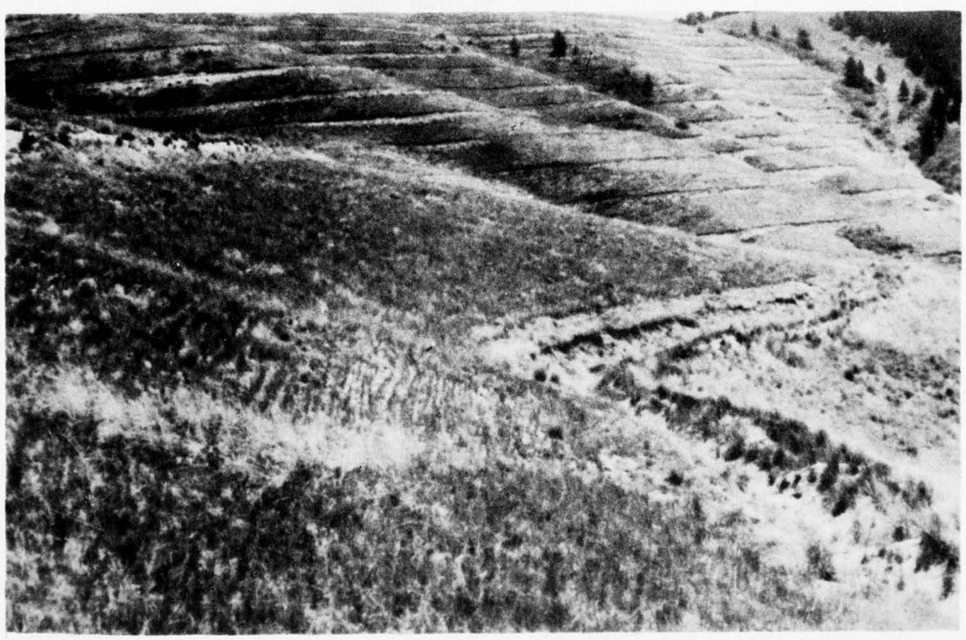
Erosion from both wind and water is common in the sandy alluvium of the valleys and sheet erosion is often evident at higher elevations. An estimated 3.3 million acres of rangeland have erosion and sediment problems. These poor condition lands present a considerable problem because of the relatively large acreage involved and their widespread distribution throughout the subregion. Rangeland produces about 3,556 acre-feet of sediment annually, nearly 72 percent of the sediment from all subregion lands (table 232).

Table 232 - Sediment Yield from Rangeland, Subregion 5, 1966

Sediment Yield 1/ Category	Grassland	Sagebrush & Shrubs	Total	Percent
		Rangeland Acreage (1,000 acres)		
Very Low	202.9	4,682.2	4,885.1	29
Low	1,484.2	9,972.1	11,456.3	68
Medium	113.9	244.5	358.4	2
High	44.8	94.1	138.9	1
Very High	--	--	--	--
Total	1,845.8	14,992.9	16,838.7	100
		Annual Sediment Yield (Acre-Feet)		
Very Low	19	439	458	13
Low	348	2,337	2,685	76
Medium	62	134	196	5
High	70	147	217	6
Very High	--	--	--	--
Total	499	3,057	3,556	100

1/ Very Low through Very High categories represent generalized range areas on which annual sediment yield per square mile averages .06, .15, .35, 1.00, and 2.75 acre-feet respectively.
Source: Derived from figures 31 and 32.

The Boise Front Watershed was left completely unprotected by fire in 1959, causing excessive Boise Flood damage. Contour terraces and grass seeding on and between terraces served to slow oversurface water, allow maximum percolation, and stop soil erosion. (Bureau of Land Management)



This picture of the Boise Front Watershed was taken four years after the previous picture. Ground cover has been re-established and the watershed is almost completely stabilized. (Bureau of Land Management)

Two-thirds of the range has an average annual yield of .15 acre-feet per square mile and about 497,000 acres have higher yields averaging between .2 and 1.5 acre-feet per square mile. Higher sediment yield areas include the Bully Creek Reservoir area west of Vale, the Arrow Rock Reservoir area east of Boise, the Black Canyon Reservoir area north of Boise, and several areas in the Weiser drainage in Washington and Adams Counties of Idaho. Other areas of serious sediment yield are the Boise Front in Ada County and the Rabbit Creek and Reynolds Creek drainages in Owyhee County.

An estimated 76,000 acres of rangeland have flood problems. These include lands along Reynolds, Rabbit, Sinker, and Jordan Creeks, and certain drainage areas of the Weiser, Payette, and Boise Rivers. The major source of flood water is spring snowmelt, usually in April, May, and June, although rainfall augmented by snowmelt and summer thunderstorms results in occasional flooding. Flooding also results from early spring rains on frozen ground, or in the winter months on unfrozen but saturated soils.

Measures and Practices for Watershed Protection

The measures and practices accomplished through 1965 for watershed protection and rehabilitation are shown on table 233. These have multiple objectives and benefits, and many of them serve both watershed and other management purposes. The major emphasis of rangeland watershed protection has been directed to: (1) revegetation by seeding and brush control; (2) expanded fire protection programs; (3) increased management of livestock through the development of management plans, fencing, and the reduction of overgrazing; and (4) water development for livestock and wildlife to provide better grazing distribution.

Cover improvement and soil stabilization practices have been applied on a total of about 1.9 million acres in this subregion. An estimated 60 percent of the 865,000 acres of range seeding and 929,000 acres of brush control have been for watershed purposes and 40 percent for other management purposes including forage production.

Significant progress has been made in adjusting livestock grazing to the current grazing capacity of the range on an estimated 5.6 million acres and achieving better livestock distribution. Development of grazing management systems has provided more efficient range use and sufficient rest periods for reestablishment of native vegetation. Some 4,600 livestock and game watering facilities developed at strategic locations on the range, and the construction of about 5,900 miles of control fence, have provided a wider and more systematic range use by game and livestock. Watershed protection measures to reduce erosion and prevent excess runoff have

Table 233 - Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, Up to 1966, Subregion 5 1/

Measures & Practices	Units	Land Ownership			Watershed Purposes 2/			
		Public 3/	Private	Total	(1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	667,800	197,500	865,300	-	x	x	-
Brush Control	Acres	417,900	511,400	929,300	-	x	x	-
Weed Control	Acres	100,100	28,600	128,700	-	x	x	-
Fertilizing	Acres	3,700	1,000	4,700	x	x	-	-
Conversion of tree cover to grass	Acres	400	100	500	-	x	x	x
Contouring, Pitting, Furrowing	Acres	140	40	180	-	x	x	x
Deep Tillage	Acres	90	25	115	x	-	-	-
Stream & Bank Stabilization	Acres	20	6	26	-	x	x	x
Waterspreading	Acres	4	250	254	-	x	-	-
Irrigation	Acres	150	50	200	-	x	x	x
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	4,600	1,300	5,900	-	x	x	-
Reducing Excessive Grazing Use	Acres	4,279,000	1,223,800	5,502,800	-	x	x	x
Livestock & Game Water Facilities	Number	3,200	1,400	4,600	-	x	x	-
Road Stabilization	Miles	500	NA 4/	NA 4/	x	-	x	x
Pollution Abatement	Miles	2	-	2	-	-	x	-
Water Control Structures								
Ponds & Small Reservoirs	Number	1,700	500	2,200	-	x	x	-
	Acre Ft.	53,200	15,200	68,400	-	x	x	-
Check Dams (Gully Plugs)	Number	1,200	400	1,600	-	x	x	-
	Cu. Yds.	48,700	13,900	62,600	-	x	x	-
Diversions	Number	20	5	25	-	x	x	x
	Cu. Yds.	72,600.	20,800	93,400	-	x	x	x

1/ Data collected from land management agencies specifically for the C-NP Study.
2/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4-Flood & Debris Control.
3/ Includes Federal, State, County and Municipal Ownership.
4/ Not available.

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COLUMBIA-NORTH PACIFIC REGION COMPREHENSIVE FRAMEWORK STUDY OF --ETC(U)
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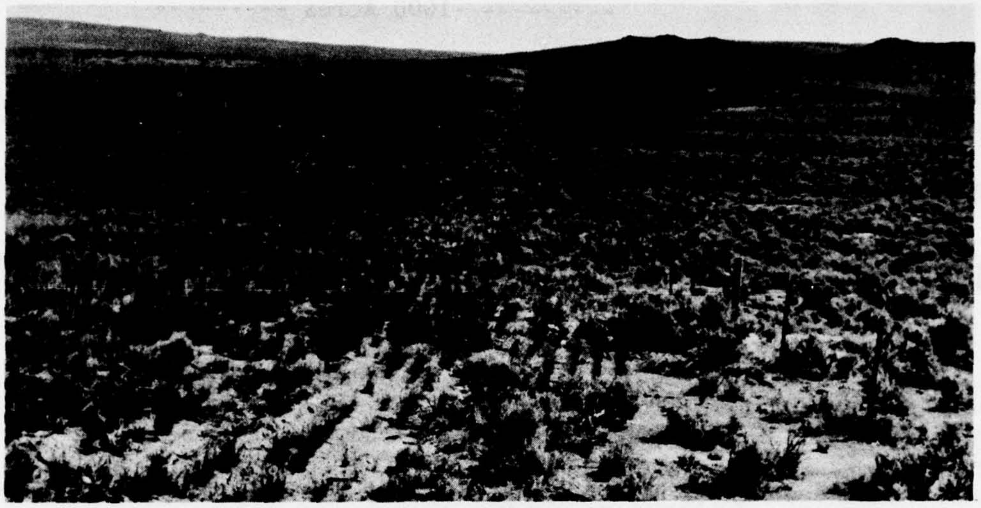
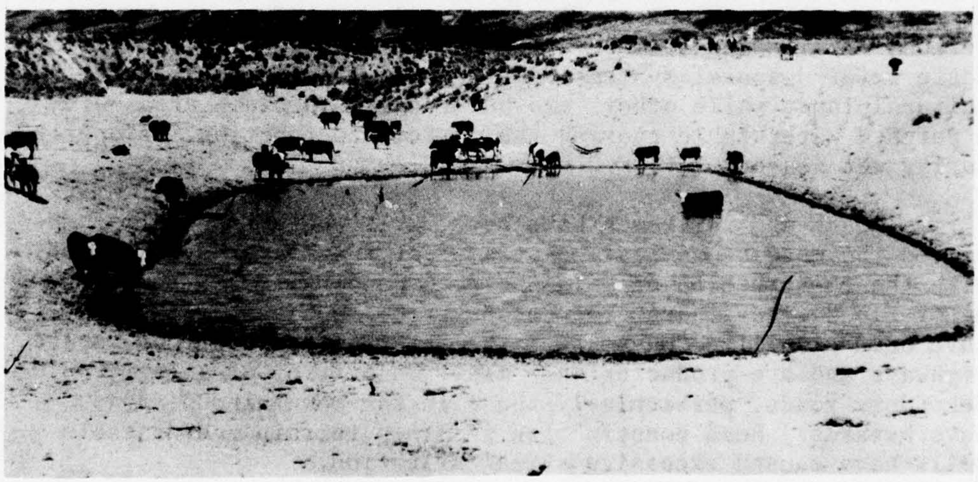
been included in the maintenance and improvement of about 500 miles of public range roads and trails as well as a number of private access ways.

Water control structures have been developed to reduce erosion, control debris, and conserve early season runoff for subsequent livestock, recreation, and fish and wildlife use. These included 2,200 ponds and small reservoirs with a combined storage capacity of 68,000 acre-feet, 1,600 check dams or gully plugs, and 25 detention dams.



Some sagebrush range areas provide inadequate ground cover and litter to prevent erosion and excessive runoff. The area on the left has been seeded for improved watershed conditions and range forage production. Range fences allow better livestock distribution and control for proper range use. (Bureau of Land Management)



To make better use of range resources, a number of ponds and small reservoirs such as this have been developed to conserve early spring runoff, provide water for livestock and game, and allow more uniform livestock distribution on the range. (Bureau of Land Management)

Other Land

Other land accounts for 3 percent of the total land area, or approximately 739,000 acres. The acreage of other land categories is shown in table 234.

Table 234 - Other Land Areas, Subregion 5

	Idaho	Oregon	Nevada	Total	Percent
	-----------1000 Acres ---------				
Small Water	10.2	18.3	9.0	37.5	5.1
Roads & Railroads	50.6	26.0	2.4	79.0	10.7
Farmsteads, Urban, Industrial & Misc.	55.8	16.8	.4	73.0	9.9
Barren Land	340.2	204.3	5.4	549.9	74.3
Total	456.8	265.4	17.2	739.4	100.0

Source: Appendix IV, Land and Mineral Resources

Many bare rock outcrops along canyons and on mountain peaks having a high rate of runoff are used for water production and wildlife habitat. Although having an extremely severe erosion problem, many areas of duneland are used for recreation. Only a small amount of water runoff is produced. The only large area of bare sand is near Bruneau, Idaho, and is approximately 2,500 acres in size.

Urban areas have expanded around initial settlements without regard for watershed problems. Over 8,000 acres of these urban areas are subject to flooding, and over 700 acres have a serious erosion and sedimentation problem. Some cities have waste water disposal systems constructed on high quality agricultural land, while others are built on flood plain areas with a perched water table causing the systems to function improperly during wet seasons.

Roads and railroads have been built where topography permitted the most economical construction. Few hazards connected with the construction of mainline roads and railroads, except minor flood areas, have been encountered. Cut and fill slopes have been stabilized on most of the interstate and primary state highways and are producing only minor quantities of silt. Secondary roads, particularly those in the mountainous areas, have hazards. Road construction in steep terrain and unstable soils have caused excessive stream siltation.

FUTURE NEEDS

This section identifies needs for watershed protection and rehabilitation as affected by projected changes in population and land use. Population is projected to increase from 253,000 in 1960 to 554,000 by 2020, an increase of 119 percent, with an accompanying demand for more urban lands and recreation use lands. Cropland is expected to increase 825,000 acres and other land uses about 91,000 acres. These increases will occur on present rangeland and forest land. Forest land is expected to decrease 62,000 acres and rangeland to decrease 942,000 acres (table 235).

Table 235 - Projected Change in Cover and Land Use
Subregion 5

	1966	1980	2000	2020
	1000 Acres			
Cropland	1,628.9	1,741.9	1,945.4	2,148.9
Forest Land	4,190.5	4,173.8	4,151.8	4,128.7
Rangeland	16,838.7	16,672.8	16,438.4	16,201.4
Other Land	739.4	763.5	795.4	830.0
Total	23,397.5	23,352.0	23,331.0	23,309.0

Source: Columbia-North Pacific Appendix VI, Economic Base and Projections.

Cropland

While the total population is expected to more than double by 2020, the farm population is expected to develop a reverse trend. Farm population will decrease from the present 48,000 to approximately 20,000 in 2020 because of farm consolidation and technological advances.

The principal cropland problems are water shortage, irrigation water management, salinity, drainage, erosion, and flooding. Some problems affect only the individual landowner and generally can be solved on an individual basis, while other problems affect an entire community and will require community efforts and cooperation. Advancing technology and changing economy will help solve some of the problems, but in turn many new problems will develop as the land is used more intensively. A survey of conservation needs shows that of 172 study areas covering the entire subregion, 91 areas need accelerated planning.

Agricultural production will increase on irrigated cropland as the acreage will almost double by 2020 while dry farmed cropland

will decrease from 208,000 to 64,000 acres. The irrigated acreage is projected to expand from 1.4 to 2.4 million acres by 2020. Table 236 shows the projected cropland trends.

Table 236 - Probable Trends in Dry and Irrigated Cropland Subregion 5

Cropland	1966	1980	2000	2020
Dry Farmed	207.9	182.0	122.0	64.0
Irrigated 1/	1,421.0	1,900.0	2,062.0	2,389.0
Total	1,628.9	2,082.0	2,184.0	2,453.0

1/ Approximately 97 percent of the total land area projections shown in Appendix IX, Irrigation.

Source: Economic Research Service, C-NPRBS Projections

Water Conservation

The acreage of irrigated cropland is projected to increase because: (1) of available land with suitable climate; (2) of adequate water from additional storage, ground water, and from Snake River; and (3) of proximity to markets.

The efficient management of water by lining canals to reduce seepage, leveling land, and installing adapted control methods and structures will distribute and control water more uniformly with less labor. It is estimated that 50 percent of the land now irrigated by flooding will shift to sprinkler systems by 2020, and essentially all of the new land will be irrigated by this method, with the trend to automated systems (table 237); thus accounting for an expected increase of irrigation efficiency from an average of 30 to 50 percent by 2020.

Table 237 - Projected Cumulative Trend in the Method of Irrigation on Cropland, Subregion 5

Item	1966	1980	2000	2020
	-------------1000 Acres-------------			
Sprinkler Systems	115.2	650.0	912.0	1,389.0
Flood Systems	1,305.8	1,250.0	1,150.0	1,000.0
Total Irrigated Area	1,421.0	1,900.0	2,062.0	2.389.0

Source: Economic Research Service, C-NPRBS Projections

Of the 1,421,000 acres presently irrigated, 399,700 acres do not have a full season water supply. Considering the time of shortage, the climates of the various water-short areas and the present efficiency, approximately 1,500,000 acre-feet of additional water would be required to provide a full season supply. Water is available for most of this area by storage or by ground water development.

Drainage

Approximately 182,000 acres of cropland need drainage. One-fourth is caused by irrigation and poor waste-water disposal. Adequate waste-water disposal facilities and good management of irrigation water are needed. Three-fourths of the wet area consists of lands with a high water table during the wet season. It is caused by unfavorable topography and soil conditions and can be controlled only by drains. Increased irrigation is expected to increase drainage needs to about 273,000 acres by 2020 (table 238).

Table 238 - Cumulative Cropland Areas Needing Drainage
Subregion 5

Item	1966	1980	2000	2020
	------------1000 Acres------------			
Wet Areas	182	204	230	273
Projected Accomplishments	46	95	127	238
Remaining	136	109	103	35

Source: Soil Conservation Service, C-NPRBS Projections

Erosion and Sedimentation

Erosion by both wind and water and the resulting sedimentation is a serious problem on cropland. It is estimated that 53 percent, or 863,000 acres, of cropland has an erosion potential. Most of this is sedimentation damage to fields, ditches, roads, streams, and reservoirs.

Present trends in farming methods and future demands in use of the land, strongly indicate an increasing erosion and sedimentation problem. To alleviate this situation more intensive watershed management practices and structural measures will be required.

Of the 863,000 acres of cropland having an erosion problem, as much as 50 percent may require some type of project action to

correct. The increase in the erosion problem and the rate at which these areas need treatment are shown in table 239.

Table 239 - Cumulative Cropland Areas Needing Erosion Control
Subregion 5

Practice	1966	1980	2000	2020
	------------1000 Acres------------			
Erosion Potential	863	1,007	1,199	1,392
Projected Accomplishments	450	677	979	1,282
Remaining	413	330	220	110

Source: Soil Conservation Service, C-NPRBS Projections

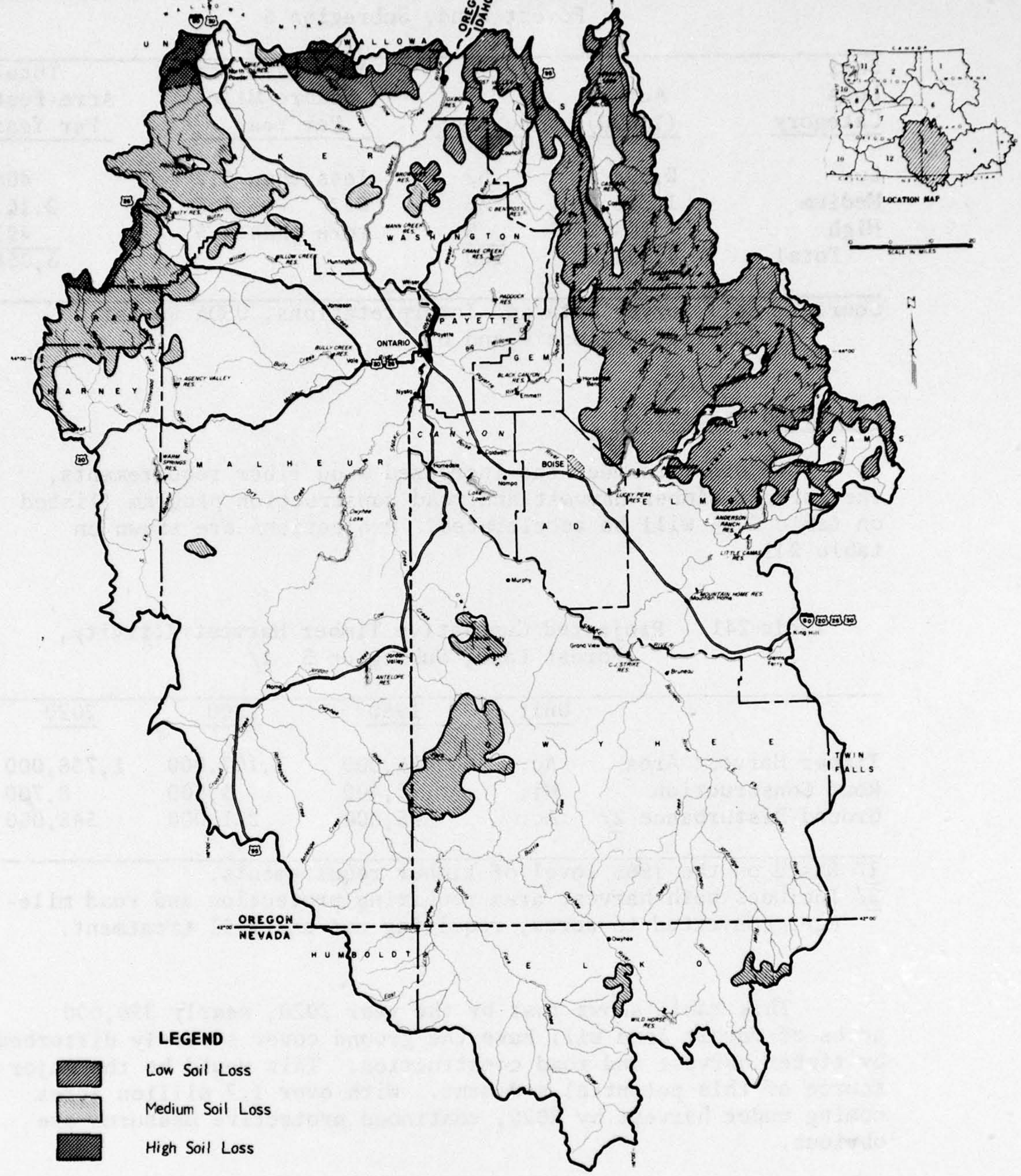
Flooding

Flood protection is needed for 79,000 acres of cropland. Flooding by streams can usually be controlled by storage and stream channel improvement. Some flooding can be prevented by reducing runoff from the watershed with land treatment measures and management practices. Complete flood protection for cropland is generally not economical at present, but greater protection will be justified as land becomes more valuable and is used more intensively.

Forest Land

Forest industries of the subregion will require an estimated 151 million cubic feet of raw material annually by the year 2020. This wood will be produced principally on the 2.8 million acres of commercial forest land projected to remain in timber production by the end of this time period. This amounts to 55 cubic feet per acre per year. The present industrial consumptive rate is 24 cubic feet per acre, while present growth is less than 15 cubic feet per acre per year. Extensive timber yield improvements will be required if present growth rates are expected to meet future industrial demands. Restocking, fertilization, thinning, and release are the principal management practices that will be employed.

Potential sediment yield and forest erosion hazard are shown on figures 32 and 33 and summarized on table 240. It represents the potential if protective measures and proper land use are disregarded. Should this occur, sediment yields would be increased more than 5 times.



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

POTENTIAL EROSION HAZARD FOREST LAND

CENTRAL SNAKE, SUBREGION 5

1968

FIGURE 33

USDA-SCS-PORTLAND, OREG. 1969

Table 240 - Potential Sediment Yield Without Protective Measures, Forest Land, Subregion 5

Soil Loss Category	Acres (1,000)	Percent	Acre-Feet Per Square Mile Per Year	Total Acre-feet Per Year
Low	2,598.3	62	less than 0.2	406
Medium	1,383.0	33	0.2 - 1.5	2.161
High	209.2	5	more than 1.5	491
Total	4,190.5	100		3,058

Source: Soil Survey Data and Interpretations, USDA Forest Service, Regions 4 and 6

Watershed Protection

In order to meet the increased wood fiber requirements, the current timber harvest and road construction program (listed on table 229) will be accelerated. Projections are shown on table 241.

Table 241 - Projected Cumulative Timber Harvest Activity, Forest Land, Subregion 5 1/

	Unit	1980	2000	2020
Timber Harvest Area	Ac.	476,000	1,107,000	1,738,000
Road Construction	Mi.	2,400	5,500	8,700
Ground Disturbance 2/	Ac.	95,000	221,000	348,000

1/ Based on the 1965 level of timber requirements.
2/ Includes both harvest area requiring protection and road mileage, converted to acres, requiring cut and fill treatment.

This table shows that by the year 2020, nearly 350,000 acres of forest land will have the ground cover severely disturbed by timber harvest and road construction. This would be the major source of this potential sediment. With over 1.7 million acres coming under harvest by 2020, continued protective measures are obvious.

Watershed Rehabilitation

Watershed rehabilitation work is essential to water quality

in all parts of the subregion. Critical areas in the medium and low yield cagetories contribute the most sediment (table 228). This is principally the result of past logging, forest fires, abandoned roads and eroding streambanks that have never been properly protected.

Water Yield Improvement

With 65 percent of the runoff originating on the forest areas, cover manipulation and snowpack management practices to increase snow accumulation and reduce snowmelt and evapotranspiration need application.

Table 242 - Water Retention Capacity, Forest Soils
Subregion 5

Retention Class	Acres (1,000)	Percent	Acre-feet Per Square Mile	Total Acre-feet
Low	3,981.3	95	less than 300	1,680,000
Medium	209.2	5	300 - 1,500	200,000
High	---	--	more than 1,500	---
Total	4,190.5	100		1,880,000

Source: Soil Survey Data and Interpretations, USDA Forest Service, Regions 4 and 6.

The Available Water Retention Capacity map (figure 34), indicates the forest soils where premeability and water retention factors offer the best opportunity to apply water yield improvement practices.

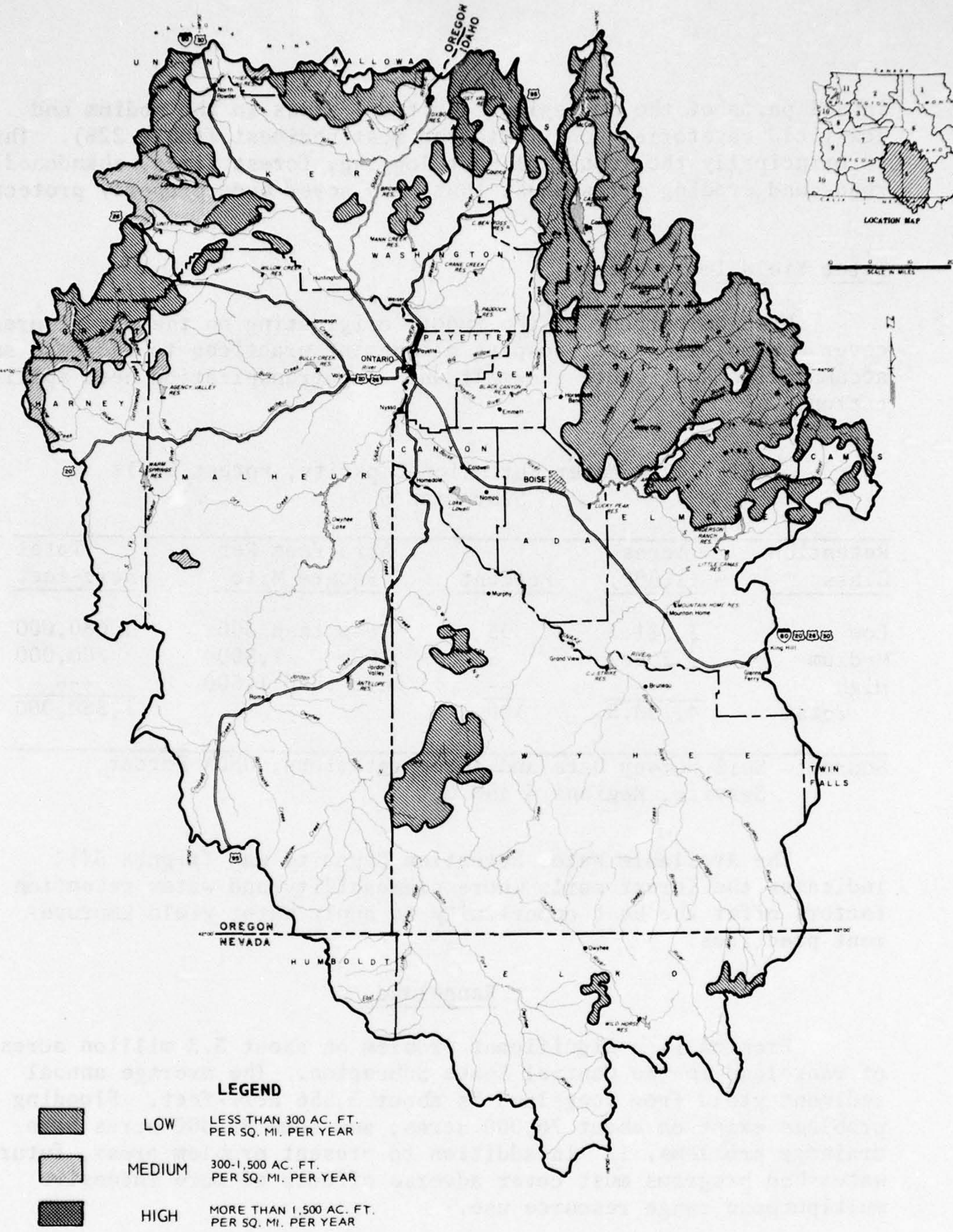
Rangeland

Erosion is a significant problem on about 3.3 million acres of rangeland in the Central Snake Subregion. The average annual sediment yield from rangeland is about 3,556 acre-feet. Flooding problems exist on about 76,000 acres; and some 35,000 acres have drainage problems. 1/ In addition to present problem areas, future watershed programs must cover adverse effects of more intensive multipurpose range resource use.

Projected Use of Range Resources

Livestock production is an important agricultural enterprise in this subregion and rangeland provides forage that produces an estimated 11.4 percent of the total beef and sheep production. Projected demand for beef and veal indicates an increase from 237.6

1/ Soil Conservation Service, C-NPRBS data.



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

WATER RETENTION CAPACITY
FOREST LAND

CENTRAL SNAKE, SUBREGION 5

1968

FIGURE 34

USDA-SCS PORTLAND, OREG. 1969

million pounds in 1964 to 654.5 million pounds or 176 percent by 2020. Sheep and lamb production is expected to decline somewhat from 14.2 million pounds in 1964 to 13.2 million pounds in 2020. (3) Although total rangeland acreage will decrease about 6 percent from 16.8 million acres in 1966 to 15.9 million acres in 2020, future range forage production must be increased to the extent commensurate with proper land management and resource utilization. Rangeland must also meet increased demands for wildlife habitat improvement and more extensive recreation uses.

Watershed Needs

An estimated 1.4 million acres of rangeland had received land treatment by 1966 for erosion and sedimentation control with accompanying flood control and drainage benefits. This includes most of the measures and practices for cover improvement and soil stabilization given in the "Present Status" section, along with accomplishments in road stabilization. Where multiple practices were involved, overlapping acreage was deleted. An additional 2.0 million acres will require treatment by 1980, 4.5 million acres by 2000, and 7.1 million acres by 2020. A number of small water control structures, such as detention dams, check dams (gully plugs), and diversion dams, are needed to assure adequate erosion and sediment control.

Protection and management practices have been extended to some 5.5 million acres of rangeland, including reduction or adjustment of livestock use to the grazing capacity of the range, and special fire control practices where required. Other associated measures needed for improved livestock distribution and control are development of stock and game water facilities and construction of control fences. Similar practices should embrace an additional 9.0 million acres by 1980, 9.5 million acres by 2000, and 9.8 million acres by 2020. Whenever feasible, watershed improvement should be accomplished by improved and more intensive management in preference to more costly construction measures which also cause greater disturbance to the environment and wildlife habitat. More information is needed on the relative importance of big game and domestic livestock and their competing use of range forage. Increased emphasis on fish and wildlife habitat, as well as recreational use of rangeland, gives further evidence of needs for comprehensive range management to meet competitive range resource demands while providing adequate watershed protection.

Considerable work required on rangeland streams and waterways includes stream clearance, channel improvement and efforts to improve water quality. Although only a few miles were reported through 1965, about 80 miles need attention by 1980, 170 miles by 2000, and 245 miles by 2020. More consideration must be given to water quality

standards and control relative to rangeland use and management. Poor water quality areas must be identified and specific measures and practices determined to achieve the objectives of improved water quality in conjunction with other range management objectives.

Along with land treatment for erosion control, an estimated 150 miles of bank stabilization is required along streams and reservoirs by 1980, 1,810 miles by 2000, and 2,725 miles by 2020. This includes stream and bank stabilization acreage given elsewhere in this report converted on the basis of 20 acres per mile.

To provide flood control and prevent damage from sediment and debris, about 14 miles of dikes are needed in range areas by 1980, 57 miles by 2000, and 86 miles by 2020. Much of this is required to reduce flood problems on downstream urban and agricultural lands.

Other Land

Most soil and water problems on other land are not critical at the present time, but changes in land use will continuously create problems. The acreage in other land is expected to increase from about 739,400 acres in 1966 to 830,000 acres in 2020, an increase of 12 percent (table 235). The requirement to accommodate the projected increase of 301,000 population will necessitate providing space for urban expansion, industrial growth, and municipal and industrial waste disposal areas. Lands for these uses will come from adjacent cropland and rangeland.

Some of the new urban developments will occur on lands which flood occasionally. The roofs and paved streets of the new development areas will increase runoff so flood protection will be needed on an estimated 4,000 acres of new developments. Erosion control will be needed on all of the land disturbed by building and road construction, and special measures will be needed to avoid serious sedimentation of nearby areas. Protection is needed for 8,000 acres of presently flooded urban area. Because many of the urban areas and potential urban areas are underlain by hardpan, provision must be made for disposal of waste water and storm runoff.

MEANS TO SATISFY NEEDS

The land measures and watershed protection needs for cropland, forest land, and rangeland are translated in this section into definite structural and vegetative programs designed to

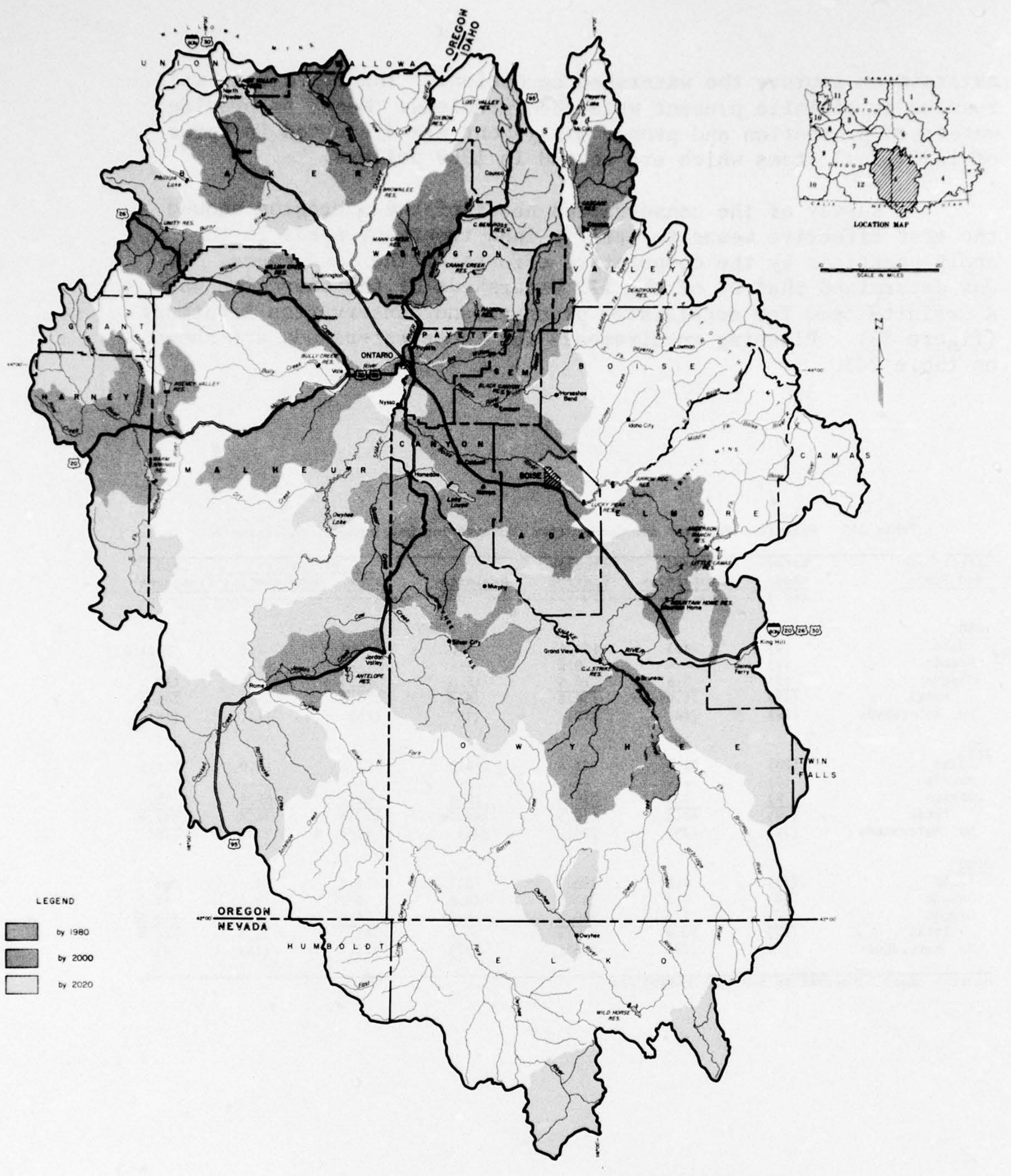
maintain or improve the watershed conditions. These programs will resolve or minimize present watershed problems. Means to provide watershed protection and proper management are discussed in terms of individual items which are costed in 1969 dollars.

A survey of the conservation needs of the subregion showed the most effective means to satisfy land treatment needs is to apply practices by the cooperative efforts of the landowners. It was determined that 95 of the 172 watersheds of the subregion have a definite need for accelerated planning and conservation treatment (figure 35). Planning requirements for these watersheds are shown on table 243.

Table 243 - Practices Required for Cooperative Conservation Development, Subregion 5

Target Date and State	Water-sheds (no.)	Flood Protection	Erosion Control	Drainage	Irrigation New	Irrigation Supplemental	Land Treatment
		(1000 Acres)					
1980							
Idaho	(9)	4.3	124.1	1.0	49.4	7.8	56.1
Nevada	(1)	---	0.2	---	---	---	---
Oregon	(9)	7.6	10.5	15.3	56.4	72.9	130.5
Total	(19)	11.9	134.8	16.3	105.8	80.7	186.6
No. Watersheds	(19)	(18)	(12)	(15)	(16)	(14)	(18)
2000							
Idaho	(20)	36.1	281.8	118.2	152.1	19.0	551.5
Nevada	(0)	---	---	---	---	---	---
Oregon	(9)	7.4	536.7	26.0	60.5	67.4	91.1
Total	(29)	43.5	818.5	144.2	212.6	86.4	642.6
No. Watersheds	(29)	(26)	(24)	(24)	(29)	(17)	(29)
2020							
Idaho	(31)	4.8	365.7	8.1	456.6	54.6	368.2
Nevada	(4)	0.3	260.0	19.9	9.7	4.7	61.7
Oregon	(12)	7.3	299.5	8.2	74.9	20.2	116.5
Total	(47)	12.4	925.2	36.2	541.2	79.5	546.4
No. Watersheds	(47)	(29)	(36)	(32)	(43)	(28)	(43)

Source: Soil Conservation Service, C-NPRBS Data



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

AREAS NEEDING COOPERATIVE WATERSHED DEVELOPMENT

CENTRAL SNAKE, SUBREGION 5

1968

FIGURE 35

Cropland

Cropland is projected to increase from 1.6 million acres in 1966 to more than 2.4 million acres by 2020. Irrigated land is expected to increase from just over 1.4 million acres in 1966 to almost 2.4 million acres by 2020. The rate at which the cropland area needs to receive irrigation water, to be drained, and to be protected from flooding and erosion damage is projected in this section along with costs. A variety of construction and land treatment practices must be applied to the land in order to meet these needs. The land area capable of producing crops is shown by capability classes in table 244.

Table 244 - Land Areas Suitable for Crop Production
Subregion 5, 1966

Capability Class 1/	Idaho	Oregon	Nevada	Total	Percent
	------	------	1000 Acres	------	
I	28.0	10.0	5.6	43.6	2
II	288.6	136.0	53.7	478.3	26
III	574.7	224.0	58.3	857.0	46
IV	269.5	168.0	53.0	490.5	26
Total	1,160.8	538.0	170.6	1,869.4	100

1/ Defined in the Glossary
Source: Appendix IV, Land and Minerals

Water Conservation

Increase in the irrigated area and shifts in the method of applying water will require intensification of irrigation water management practices. Table 245 shows some of the practices needed to provide for the efficient use of irrigation water.

Table 245 - Cumulative Projected Practices for Irrigated Cropland, Subregion 5

Practice	Units	1966	1980	2000	2020
Water Control Facilities	No.	34,841	37,000	41,000	45,000
Irrigation Water Conveyance	Mi.	10,334	10,800	11,600	12,000
Water Storage	No.	182	230	350	500
Irrigation Systems, Surface	No.	1,855	1,750	1,650	1,410
Sprinkler	No.	674	1,300	2,700	4,350
Land Shaping	1000 Acs	363	460	580	700
Irrigation Water Management	1000 Acs	238	600	1,000	1,400

Source: Soil Conservation Service, C-NPRBS Projections

Improved water conservation needs will be met by improved equipment, management techniques, and irrigator skills. These improvements will require strong and flexible programs of information, technical and financial assistance, and research to meet the needs.

Drainage

Production on approximately 136,000 acres of cropland is presently limited by wetness and will require drainage. As irrigation increases, drainage problem areas are expected to increase from the present 182,000 acres to 273,000 acres by 2020. The demand for increased agricultural production will make drainage necessary for most wet soils. Table 238 shows the projected rate at which the drainage work will be completed.

Much of the drainage problem is associated with irrigation and part of it will diminish as water is used more efficiently. Most drainage problems will require construction of tile lines or open drains which benefit two or more farms and will need project scale development. Drainage problem areas such as this are found near Bruneau, Nampa, and Emmett, Idaho, and near Nyssa, Ontario, and Vale, Oregon. Necessary drainage practices to drain the cropland areas at the projected rate are shown in table 246.

Table 246 - Cumulative Practices Required to Provide Needed Drainage, Subregion 5

Practice	Unit	1966	1980	2000	2020
Drainage Conduits & Ditches	Mi.	628	900	1,640	2,380
Drainage Structures	No.	358	500	1,200	2,000

Source: Soil Conservation Service, C-NPRBS Projections

Erosion and Sedimentation

The area to be treated will increase as the cropland acreage increases and as land use shifts from grain and forage crops to row crop use. By 2020 about 1.4 million acres of cropland will have erosion problems, however, effective erosion control practices should have been applied on 1,282,000 acres, leaving 110,000 acres to be treated later.

Wind erosion on irrigated land can be controlled by rough tillage, stubble mulching, crop residue use, and field windbreaks. Management techniques and machinery will be developed to plant sugar beets and similar crops and leave the land between the rows rough for wind protection.

Erosion on dry cropland with mild slopes can be generally controlled with management practices such as rough tillage, contour tillage, stubble mulching, and crop residue use. Steeper land will require stripcropping and construction of diversions, grassed waterways, and stream channel stabilization structures. A tillage program of chiseling in the fall and sweep cultivation for weed control on fallow land provides good erosion protection and increased infiltration rate. Across-the-slope tillage further increases infiltration and reduces erosion.

Practices necessary to treat those areas with critical erosion problems and to maintain other areas in a stable condition are shown in table 247.

Table 247 - Cumulative Practices to Satisfy Erosion Control Needs, Subregion 5

Practices	Units	1966	1980	2000	2020
Conservation Cropping System	1000 Acs.	508	900	1,300	1,800
Crop Residue Use	1000 Acs.	311	650	925	1,200
Ditch Bank Seeding	Miles	162	235	310	450
Diversions	Miles	14	100	250	400
Field Windbreaks	Miles	9	50	100	150
Grade Stabilization Structures	No.	1,226	1,800	2,400	3,000
Grassed Waterways	1000 Acs.	1	2	3	5
Pasture & Hay Land Planting	1000 Acs.	69	150	275	425
Stripcropping	1000 Acs.	5	20	35	60
Stubble Mulching	1000 Acs.	7	40	75	150

Source: Soil Conservation Service, C-NPRBS Projections

Flooding

Approximately 79,000 acres of cropland are flooded frequently. In the climatic zones where high-income crops cannot be grown, maximum production of hay and pasture without expensive flood control works will be developed. Flood channels and flood detention reservoirs will be constructed to prevent frequent flooding of high-value cropland. In some places, such as the Boise Front area northeast of Boise, watersheds will be treated to increase infiltration and reduce flood runoff. Proposed multiple purpose reservoirs on the Payette, Weiser, Powder, and Burnt Rivers will greatly reduce flooding of large areas.

Streambank erosion is a problem on some streams and will be treated by protecting the reaches which are particularly erodible. Projected stream channel and diking measures that are necessary to prevent local flooding are shown on table 248.

Table 248 - Cumulative Cropland Flood Prevention Practices, Subregion 5

Practices	Unit	1966	1980	2000	2020
Stream Channel Improvement	Miles	157	500	1,600	2,900
Stream Channel Stabilization	Miles	8	175	300	500
Stream Bank Protection	Miles	31	250	600	1,000
Dikes and Levees	Miles	46	300	700	1,200

Source: Soil Conservation Service, C-NPRBS Projections

Program Costs

The costs of implementing conservation practices discussed in the previous sections are given in table 249, based on 1969 constant dollars.

Table 249 - Estimated Cost of Cropland Conservation Practices, Subregion 5 1/

Item	Water Conservation	Drainage	Erosion Control	Flood Prevention	Total
1966-1980					
Private Funds	27,320	6,002	14,795	1,935	50,052
Public Funds	6,500	1,300	1,000	10,965	19,765
Total	33,820	7,302	15,795	12,900	69,817
1981-2000					
Private Funds	115,600	26,350	28,430	8,496	178,876
Public Funds	32,000	8,000	1,500	38,704	80,204
Total	147,600	34,350	29,930	47,200	259,080
2001-2020					
Private Funds	170,800	36,000	38,210	5,760	250,770
Public Funds	28,000	10,000	2,000	23,040	63,040
Total	198,800	46,000	40,210	28,800	313,810

1/ Soil Conservation Service, CNPRBS Projections

Forest Land

Projections for lumber, plywood, pulpwood, forage, and other forest products indicate increased demands on the forest lands of the subregion. Nonconsumptive uses, particularly recreation, will also increase demands for forest land and water. In order to meet these demands, accelerating levels of watershed protection, reduction of present sediment production, and improved streamflows through vegetation and snowfield management will be required. Land management practices go hand in hand with the structural programs designed to develop the water potential of the subregion.

Watershed Protection

It is anticipated that the standards for watershed protection, which are conducted concurrently with logging and road construction as outlined in table 229, will improve on the public

forest lands. A level, at least equal to that presently used on public lands, will be necessary for the private areas, especially on sites with a high erosion or sediment yield potential. Table 250 outlines the anticipated total cost of such measures accumulated through the year 2020. Calculations are based on the assumption that (1) on the public forest lands, controls required by timber sale and construction contracts are adequate when properly applied, and (2) on the private forest lands, the minimum required is about equal that presently required on public lands.

Table 250 - Projected Costs for Watershed Protection Practices
Forest Land, Subregion 5

Practices	Unit	Total Units 1/	Total Cost 1/ $1000
PUBLIC FOREST LAND			
Logging Disturbance Treatment	Ac.	192,900	3,858
Harvest Road Treatment 2/	Mi.	6,400	1,600
Other Watershed Requirements 3/	Ac.	3,593,000	60,692
Total Cost			66,150
PRIVATE FOREST LAND			
Logging Disturbance Treatment	Ac.	67,800	1,017
Harvest Road Treatment	Mi.	2,300	460
Other Watershed Requirements	Ac.	481,000	17,068
Total Cost			18,545
TOTAL ALL LAND			
Logging Disturbance Treatment	Ac.	260,700	4,875
Harvest Road Treatment	Mi.	8,700	2,060
Other Watershed Requirements	Ac.	4,074,000	77,760
Total Cost			84,695

1/ Total for 55-year period 1965-2020. Costs in 1969 dollars.
2/ Includes road maintenance.
3/ Includes watershed surveys, plans, fire protection, special road requirements, timber cultural practices, and other indirectly related items.

At this rate, recurrent watershed protection measures will cost about $1,200,000 annually on the public forest lands and should cost $337,000 annually on the private. Converting the annual costs to totals, this amounts to $84,700,000. This is considered the cost of maintaining the full productive condition of the forest watersheds to meet the projected demands.

Watershed Rehabilitation

The forest areas most in need of rehabilitation are in the medium sediment yield categories as listed in table 228. These are the areas presently contributing nearly 84 acre-feet per year or 15 percent of the total sediment load from the forest lands in the subregion. Table 251 lists the forest land acreage presently requiring treatment and the amount that should be accomplished during time periods 1980, 2000, and 2020. Table 252 outlines the expected sediment reduction through the application of these measures.

Table 251 - Projected Watershed Rehabilitation Programs, Forest Land, Subregion 5

Program	Unit	1980 Amount	1980 Cost 1/ $1000	2000 Amount	2000 Cost 1/ $1000	2020 Amount	2020 Cost 1/ $1000
FEDERAL LANDS							
Land Treatment	Ac.	46,500	7,646	55,500	9,539	70,000	11,013
Stream Rehabilitation	Mi.	260	852	313	1,422	275	783
Road Rehabilitation	Mi.	1,088	2,012	240	403	36	1
Total Cost			10,510		11,364		11,797
NONFEDERAL LANDS							
Land Treatment	Ac.	15,000	225	30,000	450	40,000	600
Stream Rehabilitation	Mi.	5	3	7	4	10	6
Road Rehabilitation	Mi.	72	2	60	2	34	1
Total Cost			230		456		607
TOTAL ALL LANDS							
Land Treatment	Ac.	61,500	7,871	85,500	9,989	110,000	11,613
Stream Rehabilitation	Mi.	265	855	320	1,426	285	789
Road Rehabilitation	Mi.	1,160	2,014	300	405	70	2
Total Cost			10,740		11,820		12,404

1/ In 1969 dollars

Table 252 - Expected Annual Sediment Reduction Forest Land Rehabilitation, Subregion 5

Present Yields 1/	Acres (1,000)	Total Sed. Yield Ac-ft./Yr.	Acres Treated 2/	Sediment Reduction Ac-ft./Yr.
Very Low	975.3	31	--	--
Low	2,946.5	460	81,000	10.0
Medium	268.7	84	269,000	75.6
High	--	--	--	--
Very High	--	--	--	--
Total	4,190.5	575	350,000	85.6
		Total reduction, percent		15

1/ Data from table 238
2/ Data from table 250. Miles treated converted to acres.

The overall expected sediment reduction is nearly 90 acre-feet per year. Most of this reduction will occur on lands where improper land use activities have considerably increased sediment loads over and above the base load.

In addition to the needs for sediment reduction on the presently eroding forest lands, nonrecurrent work will be required on future extensive burned areas and critically eroding areas directly related to future water storage projects. If treatment is needed, these sediment sources will be handled as they occur. Therefore, the 15 percent overall sediment reduction is that amount possible should no new sources occur through fire or other disaster.

Water Yield Improvement

Total programs and the amount that should be accomplished by time periods 1980, 2000, and 2020 are listed in table 253.

Table 253 - Projected Water Yield Improvement Practices
Public Forest Land, Subregion 5

Program	Unit	1980 Amount	1980 Cost 1/ $1000	2000 Amount	2000 Cost 1/ $1000	2020 Amount	2020 Cost 1/ $1000
Cover Manipulation 2/	Ac.	10,000	400	15,000	600	15,000	600
Snowpack Management	Mi.	25	1,250	25	1,250	30	1,500
Water Spreading 3/	Ac.	1,500	45	1,500	45	1,500	45
Total Cost			1,695		1,895		2,145

1/ In 1969 dollars
2/ Includes type conversion and riparian vegetation management.
3/ Planned for altering timing of runoff or ground-water recharge, not for irrigation or other resource activity.

Total Program Costs

In summary, the total cost of forest watershed protection and land treatment program through the year 2020 may be expressed as follows:

	Cost ($1,000)
Watershed Protection	84,695
Watershed Rehabilitation	12,404
Water Yield Improvement	2,145
	99,244

Measures and Practices for Watershed Protection

Required practices to satisfy future needs for rangeland watershed protection, rehabilitation, and improvement are listed in tables 254, 255, and 256. Most of these measures which improve watershed conditions also have other management objectives or purposes.

Cover improvement and soil stabilization practices will be required on a combined total of 10.3 million acres by 2020. Many of these will be recurring efforts and a combination of practices will be applied on some areas. About 2.5 million acres will need revegetation including 2.4 million acres of grass seeding and 66,000 acres seeded to shrubs. About half of the grass seedings will be recurring because of regular maintenance needs and failures due to drought and other causes. Some 70 percent of the revegetation efforts will be for improved watershed conditions and 30 percent for other management objectives including range forage production. More than half of the required 6.8 million acres of brush control will be recurring since seeding, maintenance spraying, and respraying brush control areas frequently exceed the recommended amortization period.

Table 254 - Required Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, 1966 to 1980, Subregion 5 1/

Measures & Practices	Units	Land Ownership			Watershed Purposes 2/			
		Public 3/	Private	Total	(1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	714,400	204,300	918,700	-	x	x	x
Brush Control	Acres	1,294,700	370,300	1,665,000	-	x	x	-
Weed Control	Acres	36,900	10,500	47,400	-	x	x	-
Fertilizing	Acres	8,000	2,300	10,300	x	x	-	-
Conversion of tree cover to grass	Acres	11,100	3,200	14,300	-	x	x	x
Contouring, Pitting, Furrowing	Acres	115,700	33,100	148,800	x	x	x	x
Stream & Bank Stabilization	Acres	2,300	700	3,000	-	x	x	x
Waterspreading	Acres	4,400	1,300	5,700	-	-	x	-
Irrigation	Acres	140	40	180	-	x	x	x
					-	x	x	x
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	8,200	2,400	10,600	-	x	x	-
Reducing Excessive Grazing	Acres	6,966,600	1,992,500	8,959,100	-	x	x	-
Livestock & Game Water Facilities	Number	7,800	2,200	10,000	-	x	x	-
Special Fire Control	Acres	1,061,300	303,500	1,364,800	-	x	x	-
Roads, Cut & Fill Stabilization								
Existing Roads	Miles	700	200	900	x	x	x	x
New Roads	Miles	900	300	1,200	x	x	x	x
Abandoned Roads	Miles	70	20	90	-	x	x	-
Stream Clearance	Miles	40	10	50	-	-	x	-
Pollution Abatement	Miles	60	20	80	-	-	x	-
Water Control Structures								
Ponds & Small Reservoirs	Number	6,500	1,900	8,400	-	x	x	-
	Acre Ft.	13,200	3,800	17,000	-	x	x	-
Detentions	Number	6	2	8	-	-	-	x
	Cu. Yds.	111,100	31,800	142,900	-	-	-	x
Check Dams (Gully Plugs)	Number	7,600	2,200	9,800	-	x	x	x
	Cu. Yds.	571,300	163,400	734,700	-	x	x	x
Dikes	Lin. Ft.	59,200	16,900	76,100	-	x	x	x
Diversions	Number	70	20	90	-	x	x	x
	Cu. Yds.	80,400	23,000	103,400	-	x	x	x

1/ Data collected from land management agencies specifically for the C-NP Study.
2/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4-Flood & Debris Control.
3/ Includes Federal, State, County and Municipal Ownership.

Table 255 - Required Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, 1981 to 2000, Subregion 5 1/

Measures & Practices	Units	Land Ownership Public 3/	Private	Total	Watershed Purposes 2/ (1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	687,500	196,600	884,100	-	x	x	x
Brush Control	Acres	1,869,800	534,800	2,404,600	-	x	x	x
Weed Control	Acres	42,500	12,100	54,600	-	x	-	-
Fertilizing	Acres	15,000	4,300	19,300	-	x	x	x
Conversion of tree cover to grass	Acres	22,800	6,500	29,300	-	x	x	x
Contouring, Pitting, Furrowing	Acres	130,200	37,200	167,400	x	x	x	x
Stream & Bank Stabilization	Acres	25,800	7,400	33,200	-	-	x	x
Waterspreading	Acres	9,400	2,700	12,100	-	x	-	-
Irrigation	Acres	150	50	200	-	x	x	x
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	5,500	1,600	7,100	-	x	x	-
Reducing Excessive Grazing Jse	Acres	444,400	127,100	571,500	-	x	-	-
Livestock & Game Water Facilities	Number	7,800	2,200	10,000	-	-	-	-
Special Fire Control	Acres	1,008,300	288,400	1,296,700	-	x	x	-
Roads, Cut & Fill Stabilization								
Existing Roads	Miles	1,200	300	1,500	x	x	x	x
New Roads	Miles	700	200	900	-	x	x	x
Abandoned Roads	Miles	11	3	14	-	-	x	x
Stream Clearance	Miles	60	20	80	-	-	x	-
Pollution Abatement	Miles	70	20	90	-	-	x	-
Water Control Structures								
Ponds & Small Reservoirs	Number	6,100	1,700	7,800	-	x	x	x
	Acre Ft.	12,200	3,500	15,700	-	x	x	x
Detentions	Number	6	2	8	-	-	-	x
	Cu. Yds.	111,100	31,800	142,900	-	-	-	x
Check Dams (Gully Plugs)	Number	8,200	2,400	10,600	-	x	x	x
	Cu. Yds.	571,200	163,400	734,600	-	x	x	x
Dikes	Lin. Ft.	176,500	50,500	227,000	-	x	-	-
Diversions	Number	60	20	80	-	x	x	x
	Cu. Yds.	219,400	62,800	282,200	-	x	x	x

1/ Data collected from land management agencies specifically for the C-NP Study.
2/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4-Flood & Debris Control.
3/ Includes Federal, State, County and Municipal Ownership.

Table 256 - Required Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, 2001 to 2020, Subregion 5 1/

Measures & Practices	Units	Land Ownership Public 3/	Private	Total	Watershed Purposes 2/ (1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	535,500	153,200	688,700	-	x	x	-
Brush Control	Acres	2,116,500	605,300	2,721,800	-	x	x	x
Weed Control	Acres	41,300	11,800	53,100	-	x	x	-
Fertilizing	Acres	45,300	13,000	58,300	-	x	x	x
Conversion of tree cover to grass	Acres	33,900	9,700	43,600	-	x	x	x
Contouring, Pitting, Furrowing	Acres	140,500	40,200	180,700	-	x	x	x
Stream & Bank Stabilization	Acres	14,200	4,100	18,300	-	x	x	x
Waterspreading	Acres	12,200	3,500	15,700	-	x	-	-
Irrigation	Acres	80	20	100	-	x	x	x
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	5,000	1,400	6,400	-	x	x	-
Reducing Excessive Grazing	Acres	222,200	63,600	285,800	-	x	-	-
Livestock & Game Water Facilities	Number	7,500	2,200	9,700	-	x	x	-
Special Fire Control	Acres	1,018,700	291,300	1,310,000	-	x	x	-
Roads, Cut & Fill Stabilization								
Existing Roads	Miles	1,000	300	1,300	-	x	x	x
New Roads	Miles	700	200	900	-	x	x	x
Abandoned Roads	Miles	11	3	14	-	-	x	x
Stream Clearance	Miles	40	15	55	-	-	x	-
Pollution Abatement	Miles	60	15	75	-	-	x	-
Water Control Structures								
Ponds & Small Reservoirs	Number	6,000	1,700	7,700	-	x	x	x
	Acre Ft.	12,000	3,400	15,400	-	x	x	x
Detentions	Number	5	1	6	-	-	-	x
	Cu. Yds.	88,900	25,400	114,300	-	-	-	x
Check Dams (Gully Plugs)	Number	5,800	1,700	7,500	-	x	x	x
	Cu. Yds.	2,400	700	3,100	-	x	x	x
Dikes	Lin. Ft.	117,900	33,700	151,600	-	x	x	x
Diversions	Number	45	10	55	-	x	x	x
	Cu. Yds.	146,700	41,900	188,600	-	x	x	x

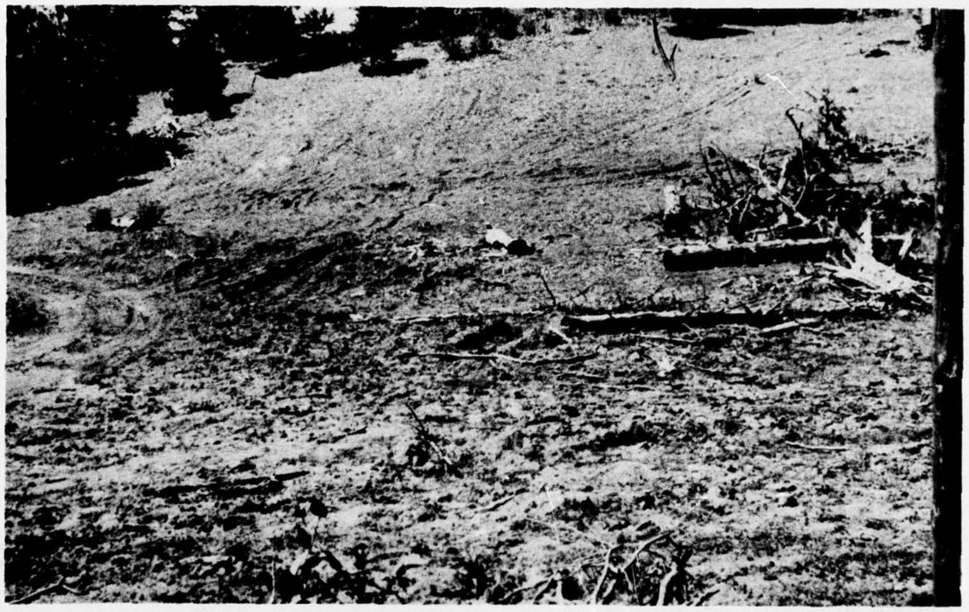
1/ Data collected from land management agencies specifically for the C-NP Study.
2/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4-Flood & Debris Control.
3/ Includes Federal, State, County and Municipal Ownership.

Other cover improvement and soil stabilization practices are important. Weeds should be controlled on about 155,000 acres. Chemical control will be needed yearly in some instances, depending on the species and control. Waterspreading is necessary on about 33,500 acres. Some waterspreading should be accomplished in conjunction with the fertilizing of 88,000 acres. Scattered juniper on 87,000 acres must be removed to develop grass cover. About 497,000 acres of contouring, pitting, or furrowing will be necessary, primarily as additional erosion and flood control measures. An estimated 54,500 acres (approximately 2,700 miles) along streams or above reservoirs will require soil stabilizing practices.

Watershed and soil surveys must be made to provide guidance for more comprehensive watershed management. In addition to the 6.7 million acres of range now covered by soil surveys, another 9.5 million acres should be mapped by 2020. Watershed plans which now cover about 5.2 million acres, should be increased to about 15.0 million acres by 2020.

Brush control will be accomplished on some rangeland by plowing to break the hardened top soil and preparation for replacement with more useful, protective, and erosion resistant vegetation, as in this area near Baker, Oregon. (Bureau of Land Management)

Excessive grazing had been reduced on about 5.5 million acres through 1965, and an additional 9.8 million acres will require adjustment by 2020 to assure that grazing use is compatible with range condition and grazing capacity. Livestock use should be restricted on a seasonal or permanent basis as is necessary to prevent further damage to the watershed, to rehabilitate deteriorated areas, or to allow increased utilization by big game. Grazing management systems should be improved to increase the grazing capacity and provide adequate cover improvement and soil stabilization for watershed protection. About 24,000 miles of livestock fence should be constructed and an additional 29,700 livestock and game water facilities, such as springs, wells, troughs, ponds, and guzzlers, are needed for broader and more uniform distribution of livestock, conservation of existing water supplies, and preservation of the quality of water.



Overgrazing in the high country above the South Fork of the Payette River has left this area unprotected and subject to gully rill erosion. Grazing use must be adjusted while protective cover is being re-established. (Bureau of Land Management)

Control of range fires is essential to protect the forage crop and watershed cover, and additional financial resources are needed by some fire protection agencies to permit control of fires while they are still small. Special fire prevention efforts will be required on about 4.0 million acres, including extra fire patrol, fire breaks, and the development of facilities for fire control water supply. On about 3,700 miles of existing roads and 3,000 miles of new roads, needs exist for ditches and culverts to control run-off; mulching, fertilizing, or seeding to protect cut and fill slopes; and facilities to protect culvert outfalls. Approximately 120 miles of abandoned roads will require rehabilitation by scarification, waterbarring, and seeding. Stream clearance, including removal of debris, vegetation, and gravel bars from water courses to allow natural streamflow is needed along some 190 miles of waterways. Pollution abatement measures are required along about 250 miles of streams by restricting livestock use directly in streams and springs and providing sanitary facilities for recreation use near waterways and lakes.

Required water control structures between 1966 and 2020 include about 23,900 ponds and small reservoirs with a combined storage capacity of some 48,100 acre-feet, about 250 diversion or detention dams, 28,000 check dams or gully plugs, and 86 miles of dikes.

Erosion and Sediment Yield Improvement

Practices shown on tables 254, 255, and 256 for erosion and water quality control should be concentrated on areas of highest sediment yield. About 270,000 acres, in the "High" and "Medium" sediment yield categories shown on table 232, produce between .35 and 1.00 acre-feet of sediment per square mile annually. A number of small areas within the generalized "Low" sediment yield category also have high yields. Reduction or redistribution of grazing use on some areas and improved vegetative cover should result in an approximate reduction of 55 percent of the annual sediment yield from 3,556 acre-feet in 1966 to 1,597 acre-feet in 2020 (table 257).

Table 257 - Sediment Yield Projections from Rangeland, Subregion 5

Sediment Yield Categories 1/	1966	1980	2000	2020
		Rangeland Acreage (1,000 Acres)		
Very Low	4,885.1	7,304.9	11,478.2	15,427.5
Low	11,456.3	8,625.1	4,455.4	338.4
Medium	358.4	298.4	214.9	131.1
High	138.9	103.6	51.5	---
Very High	---	---	---	---
Total	16,838.7	16,332.0	16,200.0	15,897.0
Percent Change from 1966	.0	-3.0	-3.8	-5.6
		Annual Sediment Yield (Acre-Feet)		
Very Low	458	685	1,076	1,446
Low	2,685	2,021	1,044	79
Medium	196	163	117	72
High	217	162	81	---
Very High	---	---	---	---
Total	3,556	3,031	2,318	1,597
Percent Change from 1966	0	-15	-35	-55

1/ Very Low through Very High categories represent generalized range areas on which annual sediment yield per square mile averages .06, .15, .35, 1.00, and 2.75 acre-feet respectively.

Improved Range Condition and Capacity

Anticipated range improvement, shown on table 258, will result in part from the accomplishment of required measures and practices for watershed protection, given in tables 254, 255, and 256, and partly from management practices for improved forage production. In 1966, only 2.7 million acres or 16 percent of the rangeland was in good range condition. With scheduled improvements, good condition range will be increased to 11.5 million acres in 2020 or 72 percent of all rangeland. Major rehabilitation efforts will be directed to poor condition rangeland, which accounted for 39 percent of the range in 1966. This will drop to

Table 258 - Estimated Potential Rangeland Improvement, Subregion 5

Range Type and Condition	1966 Acres (1,000)	1966 AUM's (1,000)	1980 Acres (1,000)	1980 AUM's (1,000)	2000 Acres (1,000)	2000 AUM's (1,000)	2020 Acres (1,000)	2020 AUM's (1,000)
Grassland								
Good	83.1	20.8	146.3	36.6	1,239.2	309.8	1,878.3	469.6
Fair	193.6	24.8	380.2	48.7	1,349.9	173.0	776.7	99.6
Poor	760.5	44.8	479.5	28.2	332.9	19.6	212.3	12.5
Seeded Range	808.6	231.0	1,590.1	454.3	1,796.9	513.4	1,968.3	562.3
Total	1,845.8	321.4	2,596.1	567.8	4,718.9	1,015.8	4,835.6	1,144.0
Sagebrush								
Good	1,595.6	212.8	3,548.7	473.2	5,677.6	757.0	7,119.0	949.2
Fair	6,877.4	573.1	5,437.8	453.1	3,154.2	262.9	2,048.4	170.7
Poor	5,281.8	251.5	3,548.6	169.0	1,458.2	69.4	725.1	34.5
Total	13,754.8	1,037.4	12,535.1	1,095.3	10,290.0	1,089.3	9,892.5	1,154.4
Other Brush								
Good	187.9	18.8	256.2	25.6	371.1	37.1	538.8	53.9
Fair	508.4	33.4	471.7	31.1	444.7	29.3	372.3	24.5
Poor	541.8	22.5	472.9	19.6	375.3	15.6	257.8	10.7
Total	1,238.1	74.7	1,200.8	76.3	1,191.1	82.0	1,168.9	89.1
Total								
Good 1/	2,675.2	483.4	5,541.3	989.7	9,084.8	1,617.3	11,504.4	2,035.0
Fair	7,579.4	631.3	6,289.7	532.9	4,948.8	465.2	3,197.4	294.8
Poor	6,584.1	318.8	4,501.0	216.8	2,166.4	104.6	1,195.2	57.7
Grand Total	16,838.7	1,433.5	16,332.0	1,739.4	16,200.0	2,187.1	15,897.0	2,387.5
Average AC/AUM	11.7		9.4		7.4		6.7	
Percent change from 1966	.0	.0	-3.0	+21.3	-3.8	+52.6	-5.6	+66.6

1/ Includes seeded range.
Source: Table 231 - "Present Status" rangeland narrative. Future estimates for this study are based on representative on-site surveys for production guides with consideration to the capability of the range for improvement with proper management and utilization.

8 percent by 2020, a decrease from 6.6 million acres to 1.2 million acres. Despite a reduction of 942,000 acres of rangeland by 2020, the 1966 grazing capacity of 1.4 million animal unit months is expected to increase to 2.4 million animal unit months in 2020 (an increase of 67 percent).

Even with this significant improvement in grazing capacity, range forage production will meet only about 7.2 percent of the anticipated demand for livestock production in Subregion 5 by 2020 compared to 11.4 percent in 1966.

Estimated Program Investment Costs

Investment cost estimates (based on 1969 dollars) are given in table 259 for all future measures and practices shown on tables 254, 255, and 256. Cover improvement and soil stabilization programs will require $66.0 million between 1966 and 2020, 59 percent of the total $112.0 million rangeland watershed costs. Watershed oriented land management costs require $13.4 million or 12 percent of program costs, and water control structures require $32.6 million or 29 percent of all costs.

Table 259 - Estimated Cost of Required Measures and Practices for Watershed Protection and Rehabilitation of Rangeland by Major Types of Watershed Programs, Subregion 5 1/

Major Types of Watershed Programs	1966 to 1980 ($1000)	1980 to 2000 ($1000)	2000 to 2020 ($1000)	Total ($1000)
Public Land				
Cover Improvement and Soil Stabilization	7,957.9	25,081.6	18,209.5	51,249.0
Watershed Oriented Land Management Practices	5,260.9	2,331.8	2,839.8	10,432.5
Water Control Structures	8,151.3	8,724.1	8,354.4	25,229.8
Total	21,370.1	36,137.5	29,403.7	86,911.3
Private Land				
Cover Improvement and Soil Stabilization	2,282.1	7,190.4	5,233.3	14,705.8
Watershed Oriented Land Management Practices	1,516.5	677.7	812.0	3,006.2
Water Control Structures	173.7	4,847.4	2,367.9	7,389.0
Total	3,972.3	12,715.5	8,413.2	25,101.0
Total				
Cover Improvement and Soil Stabilization	10,240.0	32,272.0	23,442.8	65,954.8
Watershed Oriented Land Management Practices	6,777.4	3,009.5	3,651.8	13,438.7
Water Control Structures	8,325.0	13,571.5	10,722.3	32,618.8
Total	25,342.4	48,853.0	37,816.9	112,012.3

1/ Based on measures and practices shown on tables 253, 254, and 255 with constant 1969 dollars.

Based on the present ratio of land ownership, an estimated $86.9 million will be needed for the public range (78 percent of total requirements). The private range will require $25.1 million or 22 percent of all expenditures.

Other Land

Urban areas, roads, and recreation areas to accommodate the increased population can avoid many flood, erosion, and drainage problems by good planning which recognizes the particular hazards of the various sites. Other land must increase by approximately 91,000 acres by 2020 to meet projected needs for urban growth, commercial and industrial development, roads, water storage, and recreational expansion. This increase will occur by a shift from cropland, forest land, and rangeland.

Barren areas such as rockland, duneland, and snowfields must be maintained in their natural condition of cover and use to satisfy water yield, recreation, and esthetic values.

Water areas must be protected from salt accumulation, sedimentation, and other forms of pollution. Flood protection will be greatly enhanced by the same flood detention reservoirs and practices listed in the cropland sections. These reservoirs can incorporate multiple-use storage for recreational, municipal, and industrial uses.

Protection of the land areas from deterioration by erosion, sedimentation, salt accumulation, and wetness can be accomplished by maintenance of ground cover and suitable drainage and flood control practices. New developments of urban, industrial, recreational, and commercial uses will necessitate regulations of use by zoning ordinances and subdivision regulations as a means to protect the land best suited for agriculture from urban encroachment and to plan for suitable areas for sewage filter fields, lagoon disposal units, sanitary landfills, and aggregate recovery sites. Soil surveys and interpretive analyses will provide basic data needed by planners to accomplish future land use changes.

Sediment causing damage to urban areas, roads, and other developments generally originates on adjacent cropland, forest land, and rangeland. Treatment of these lands as discussed earlier is important to protect other lands from sediment damage. Many of the necessary structures and land management measures have been included and costed elsewhere in this appendix and in Appendices VII, Flood Control; IX, Irrigation; XI, Municipal and Industrial Water Supply; and XII, Water Quality and Pollution Control.

PARTICIPATING STATES AND AGENCIES

STATES

Idaho	Nevada	Utah	Wyoming
Montana	Oregon	Washington	

FEDERAL AGENCIES

Department of Agriculture
- Economic Research Service
- Forest Service
- Soil Conservation Service

Department of the Army
- Corps of Engineers

Department of Commerce
- Economic Development Adm.
- National Oceanic & Atmospheric Administration
  - National Weather Service
  - National Marine Fisheries Service

Department of Health, Education, & Welfare
- Public Health Service

Department of Housing & Urban Development

Department of Transportation

Department of the Interior
- Bonneville Power Adm.
- Bureau of Indian Affairs
- Bureau of Land Management
- Bureau of Mines
- Bureau of Outdoor Recreation
- Bureau of Reclamation
- Fish and Wildlife Service
- Geological Survey
- National Park Service

Department of Labor

Environmental Protection Agency

Federal Power Commission